1986

Field Crop Production Recommendations for Manitoba

86-01653/

1986
FIELD CROP
PRODUCTION RECOMMENDATIONS
FOR MANITOBA

As approved November, 1985 by the
Manitoba Agricultural Services
Co-ordinating Committee

MANITOBA AGRICULTURAL SERVICES COORDINATING COMMITTEE

Agriculture Canada has a number of Canada Agricultural Services Coordinating Committees (CASCC) whose function is to provide a vehicle for recommendations on a wide range of agricultural activities including research to Agriculture Canada. Under each CASCC committee, referred to as Canada Committees are a number of "expert committees" who meet on an annual basis. They provide recommendations to CASCC and to coordinate the great diversity of agricultural activities.

On the provincial level, similar organizations exist. In Manitoba the overall committee is the Manitoba Agricultural Services Coordinating Committee (MASCC). This main committee is composed of a number of "lead" committees each with a number of sub-committees. The lead committee chairmen are automatically designated as members of the main MASC Committee. There are a number of duties allocated to the lead committees but their main function is to act as a vehicle for recommendations that are passed to MASCC. In turn, MASCC selects, priorizes, and passes them to the appropriate Canada Committees, particularly where Agricultural Canada action is requested.

The Crop Science Lead Committee of MASCC has an additional function of providing crop variety recommendations, a duty assumed by the Agronomists' Conference in the past. The various sub-committees under the Crop Science Lead Committee provide the necessary expertise, review the data and propose variety recommendations on cereal, special, and forage crops grown in Manitoba. These recommendations are discussed, ratified, or rejected at an annual meeting of the Crop Science Lead Committee at which all members of the sub-committees are expected to attend. The final crop production and variety recommendations are printed annually in the Field Crop Variety Recommendations for Manitoba and Field Crop Production Recommendations publications.

MASCC's Soil Science Lead Committee provides a similar function in proposing recommendations on all aspects of fertilizer applications and rates.

The Agronomy Conference no longer assumes the responsibility of field crop recommendations but functions as a forum for agricultural scientists, extension workers, and farmers to participate in an exchange of information.

This publication is designed to provide up-to-date production recommendations for growing field crops. Additional information is available in printed form from Manitoba Agriculture. Contact your local Agricultural Representative office, or write to:

MANITOBA AGRICULTURE
Publications Distribution
411 York Avenue
Winnipeg, Manitoba, R3C 3M1
Telephone: (204) 945-3846

Ask for the *List of Publications* and information on a specific crop.

CONTENTS

Introduction

Use of Good Seed 6
Crop Production 6
Intensive Crop Management (ICM) 6
Disease Control 7
Weed Control 14
Guidelines for Successful Weed Control 14
Herbicide Residues 14
Insect Pests 15

Fertilizer Use

Soil Testing 16
Major Nutrients for Annual Crop Production 16
Micro-Nutrients 20
Plant Tissue Analysis 20
Organic Soils 20
Erosion Control 23
Minimum Tillage 24
Zero Tillage 24

Variety Recommendations and Descriptions 25

Cereal Crops

Barley 26
Oats 28
Rye 29
Triticale 30
Wheat 32
Winter Wheat 34

Oilseed and Special Crops

Buckwheat 37
Canaryseed 38
Canola-Rapeseed 38
Fababeans 41
Field Beans 42
Field Peas 43
Flax 45
Lentils 46
Mustard 47
Potatoes 50
Safflower 52
Soybeans 52
Sugar Beets 53
Sunflowers 55
Wild Rice 57
Corn 59

Forage Crops

Seeding Practices 64
General Management of Grass and Legumes 70
Making Good Quality Hay and Silage 74
Pastures and Pasture Management 76

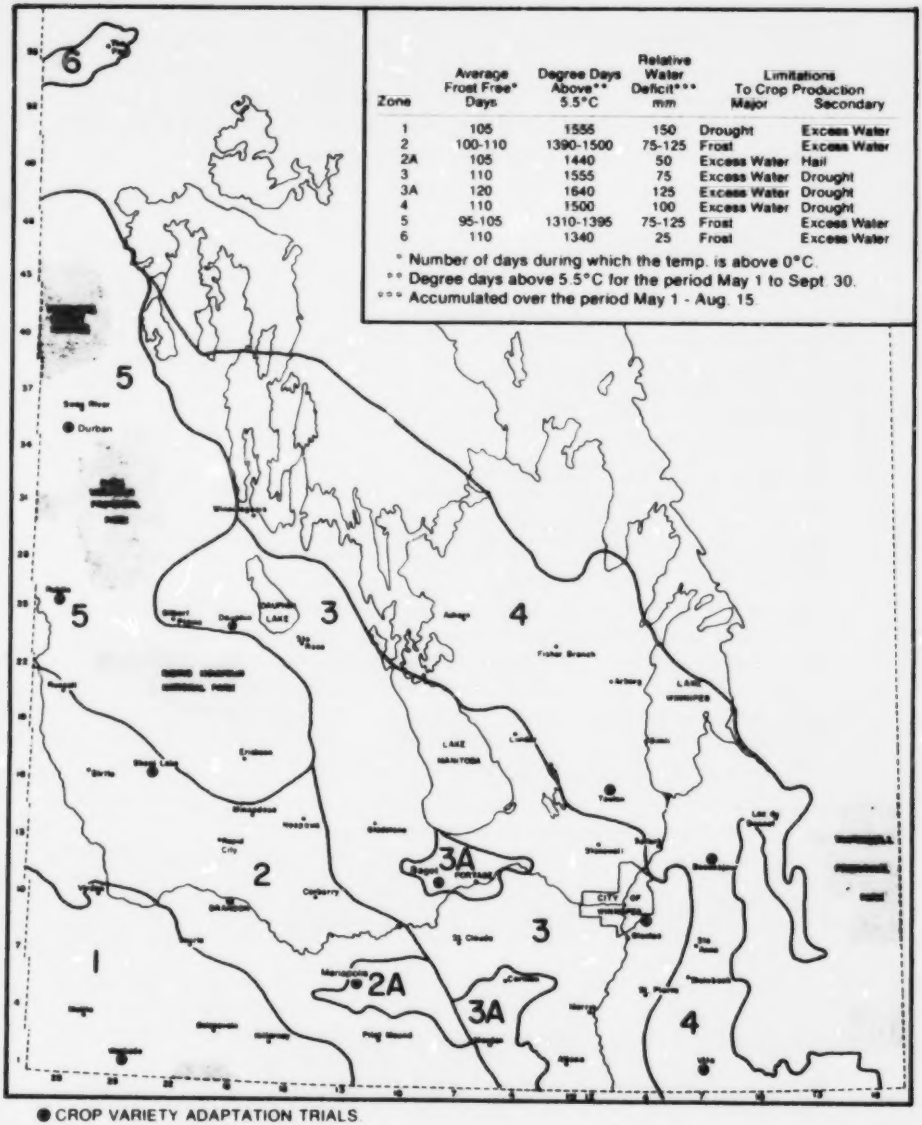
TABLES

1. Crop — Disease Relationships 9
2. Seed Treatment Fungicides and Insecticides 10
3. Insect Pests 15
4. Common Fertilizers 22

FIGURES

Crop Variety Zone Map for Manitoba 5
1. Corn Heat Unit Map for Manitoba 59
2. Minimum Accumulation of Corn Heat Units at a 25% Risk 60
3. Minimum Accumulation of Corn Heat Units at a 10% Risk 61
4. Certified/Pedigreed Seed Tag 67
5. Nutrient Changes in Alfalfa and Bromegrass 75
6. Forage Harvest and Storage Losses 76

CROP VARIETY ZONE MAP FOR MANITOBA



Zone	Average Frost Free* Days	Degree Days Above** 5.5°C	Relative Water Deficit*** mm	Limitations To Crop Production Major	Secondary
1	105	1555	150	Drought	Excess Water
2	100-110	1390-1500	75-125	Frost	Excess Water
2A	105	1440	50	Excess Water	Hail
3	110	1555	75	Excess Water	Drought
3A	120	1640	125	Excess Water	Drought
4	110	1500	100	Excess Water	Drought
5	95-105	1310-1395	75-125	Frost	Excess Water
6	110	1340	25	Frost	Excess Water

* Number of days during which the temp. is above 0°C.
** Degree days above 5.5°C for the period May 1 to Sept. 30.
*** Accumulated over the period May 1 - Aug. 15.

● CROP VARIETY ADAPTATION TRIALS

INTRODUCTION

Use of Good Seed

Always use good, preferably pedigreed seed of a recommended variety. Pedigreed seed consistently outyields poorly cleaned seed. Thorough cleaning removes weed seeds and most diseased kernels and retains only the large kernels which produce larger, more vigorous plants.

Crop Production

Successful crop production depends on a number of inter-related factors. This must be kept in mind when making decisions on production inputs. Factors to be considered include:

- seedbed type and preparation,
- seed variety and quality,
- seed treatment,
- seeding methodology and timing,
- fertilizer application,
- pest control including weeds, insects and plant diseases,
- harvesting methods.

In general, optimum results are obtained when the proper balance of inputs is tailored to the particular soil and climatic conditions involved. For example, maximum returns from good quality seed and fertilizer are only achieved when accompanied by other management factors such as timelineness and good pest control. In addition, the level of inputs required will depend upon the particular soil and climatic factors involved such as moisture holding capacity of the soil or rainfall and frost free periods.

Deciding which crop to grow not only involves the cultural practices of each crop but also the economic decisions as well.

To assist farmers in making these decisions Manitoba Agriculture has developed a Crop Planning Guide, which estimates costs and returns for various crops. The Crop Planning Guide is available through your local Ag Rep office.

Intensive Crop Management (ICM)

ICM is the production of a crop where each management input is applied at the optimum rate and time. ICM begins with seedbed preparation, seed selection, seed treatment, seeding rate and methodology, fertilizer application, and weed, insect and disease control. It may also include the use of plant growth regulators (PGR's) to control lodging.

Experience in Europe has indicated that as crop production is intensified by the use of higher plant populations and fertilizer, the need for higher levels of disease control and lodging resistance are required. In Manitoba, except for winter wheat and certain special crops such as canola (rapeseed) and potatoes which are very susceptible to disease, fungicides have not been adequately evaluated. Although research has been conducted on the use of PGR's on some cultivars of barley and wheat, more work is required before specific recommendations on rates and stages of application for the different cultivars are available for Manitoba.

Disease Control

Seed Treatment Chemical seed treatments can be used to control insects and diseases, such as smuts which attack wheat, barley, oats and rye, and flea beetles that infest canola, rapeseed and mustard.

In control of smuts, no yield benefits result from treating sound seed of disease free or a resistant variety. When smut is observed in a crop being used for seed, it should be treated. If a producer uses own seed of a susceptible variety and there is doubt as to infection by smut or bunt, seed treatment is a wise precaution. The recommended interval between treatments is given for the various crops in the Agriculture Canada publication 1766/E 1984 Smut Diseases of Wheat, Barley, Oats and Rye. This publication will also assist producers in identifying smut.

Use a suitable chemical with a Pest Control Products Act number (PCP No.). Recommended chemicals are shown in Table 1. Seed treatment chemicals are poisonous so guard against inhaling dust or fumes, and wear a mask where recommended on the product label. Wash with soap and water periodically to remove chemical lodging on hands and face while treating.

Thoroughly clean equipment used in moving treated grain before it is used for untreated grain. Empty chemical containers should be crushed and buried at least 50 cm (20 in) deep in a place where they will not contaminate water supplies.

CAUTION: Treated grain must not be mixed with untreated grain for feed or sale. Treated leftover seed may be saved for planting the following year; otherwise it should be buried at a depth and location where it will not be accessible to animals or contaminate water supplies.

Sclerotinia Diseases *Sclerotinia sclerotiorum* can cause serious disease in a great variety of broadleaved field crops including fababeans, field beans, field peas, lentils, mustard, canola, rapeseed, safflower, soybeans and sunflower. Vegetable crops such as green beans and garden peas, along with many weeds such as thistles, wild mustard, ragweed, and burdock are hosts.

The pathogen overwinters in Manitoba soils by means of black, hard bodies or sclerotia, variable in shape (round, flat, short, elongated) and

size measuring from a few millimetres to several centimetres. Infection is caused in two ways:

- by direct mycelial germination,
- by airborne ascospores produced by inconspicuous, tiny mushrooms or apothecia.

Direct mycelial germination causes root infection and occurs primarily in sunflowers. This infection results in root rot and basal stem rot, noticeable by a wet lesion at the stem base and a sudden wilting of the plant. Infection by ascospores causes head and stalk rot in sunflower, and white mold or stem rot in other crops. Ascospore infection occurs under conditions of continuous heavy rainfall inducing development of apothecia and release of ascospores.

Airborne infections are conditioned further by the presence of senescent tissue such as florets of sunflower heads and flower petals of other crops that drop and become lodged in leaf axils. Senescent tissue is needed by the germinating ascospore, and serves as a food base for the infection to be successful.

Sclerotina diseases are partially controlled by rotation allowing at least four years between host crops, use of seed free of sclerotia, and with weed control. Airborne infections are further reduced by plantings allowing maximum air circulation and fast drying, and by timely spraying with recommended chemicals on approved crops. With sunflowers, damage from Sclerotinia Wilt is reduced by using minimum populations planted at maximum distances (refer to Sunflower section — Seeding).

***Rhizobium* — Fungicide Toxicity** The viability of Rhizobium inoculum applied to pulse crop seeds may be reduced by seed treatment fungicides. Current research indicates that captan may be more detrimental to Rhizobium viability than thiram or carbathiin.

Crop Rotations Alternating of broadleaf and cereal crops is generally recommended; specific cases are discussed under individual crop sections. Further information on crop rotation can be obtained from Manitoba Agriculture Crop Rotation Chart.

A table detailing some common diseases of field crops in Manitoba follows (Table 1). It indicates which occur on more than one crop, and the longevity of these diseases in the field in the absence of a susceptible host.

TABLE 1: CROP — DISEASE RELATIONSHIPS

For Crop Rotation Consideration / DISEASES	CROP																					
	ALFALFA	BARLEY	BUCKWHEAT	CORN	FABABEANS	FIELD BEANS	FIELD PEAS	FLAX	LENTILS	MUSTARD	OATS	POTATOES	RAPESEED	RYE	TRITICALE	SAFFLOWER	SOYBEANS	SUGAR BEETS	SUNFLOWERS	SWEET CLOVER	WHEAT	LONGEVITY *
Ascochyta Blight					A		B		C													4
Alternaria-Grey Leaf Spot										X			X									1
Bacterial Blight						A	B										C					1
Cyst Nematode										X			X					X				3
Ergot		X												X	X						X	1
Fusarium Wilt & Root Rot	X				X	X	X	X	X	X			X				X		X	X		S
Gibberella — Fusarium Head Blight		X		X																	X	1
Helminthosporium — Common Root Rot		X																			X	2
Rhizoctonia Root Rot	X		X		X	X	X	X	X	X		X	X				X	X	X	X			S
Sclerotinia	X				X	X	X		X	X		X	X			X	X		X	X		4
Septoria (Cereals)		X									X										X	1
Verticillium Wilt	X											X							X	X		4
White Rust — Staghead										A			B									3

Diseases with different letters have same name on various crops but are caused by different species or biotypes of the pathogen. This implies that there is little risk of this disease spreading between the indicated crops.

* = longevity of pathogen in soil or on trash in years.

S = pathogen is a soil organism and can survive indefinitely.

X = disease can occur on crop.

TABLE 2: SEED TREATMENT FUNGICIDES AND INSECTICIDES

ACTIVE INGREDIENTS	INSECT: WIREWORMS: Wheat	Oats	Barley	Rye	Flax	SEED MAGGOTS: Field Beans	Corn	Soybeans	FLEA BEETLES: Canola (Rapeseed)	Mustard	DISEASE: SEED AND SEEDLING ROTS/BLIGHTS: Canola (Rapeseed)	Mustard	Peas	Cereals	Flax	Rye	Corn	Field Beans	Soybeans	SMUTS CARRIED ON SEED: Corn-Head Smut	Rye-Stem Smut	Wheat-Bunt	Oats-Smut	Barley-Covered	Barley-False Loose	IN SEED: Wheat-Loose Smut	Barley-Loose Smut	BLACK LEG: Canola (Rapeseed)	Verticillium Wilt: Alfalfa
INSECTICIDES																													
carbofuran (Gr)									●	●																			
lindane (Wp)	●	●	●	●																									
terbufos (Gr)									●	●																			
FUNGICIDES																													
benomyl-thiram (Du)											●																	●	
captan (Du, Wp)													●				●	●	●										
carbathiin (Sn)															●	●					●	●	●	●	●	●	●		
carbathiin-thiram (Du) (Su)															● ●	● ●	●		● ●	●	●	● ●	● ●	● ●	● ●	● ●	● ●		
maneb (Du, Su)														●	●	●							●	●	●	●			
mancozeb (Wp)															●								●	●	●	●			
metiram (Du, Su)															●		●						●	●	●	●			
thiram (Wp, Su)													●	●			●	●	●										●

TABLE 2: SEED TREATMENT FUNGICIDES AND INSECTICIDES (CONT.)

ACTIVE INGREDIENTS	INSECT: WIREWORMS: Wheat	Oats	Barley	Rye	Flax	SEED MAGGOTS: Field Beans	Corn	Soybeans	FLEA BEETLES: Canola (Rapeseed)	Mustard	DISEASE: SEED AND SEEDLING ROTS/BLIGHTS: Canola (Rapeseed)	Mustard	Peas	Cereals	Flax	Rye	Corn	Field Beans	Soybeans	SMUTS CARRIED ON SEED: Corn-Head Smut	Rye-Stem Smut	Wheat-Bunt	Oats-Smut	Barley-Covered	Barley-False Loose	SMUTS CARRIED IN SEED: Wheat-Loose Smut	Barley-Loose Smut	BLACK LEG: Canola (Rapeseed)	Verticillium Wilt: Alfalfa
DUAL PURPOSE																														
benomyl-captan lindane (Du, Su)									●	●	●	●																	●	
benomyl-thiram lindane (Du)									● ●		● ●																		● ●	
captan, diazinon (Wp)						●	●	●					●				●	●	●											
captan-lindane (Du)									●	●	●	●																		
captan-lindane-diazinon (Du)						●	●	●					●				●	●	●											
carbathiin-lindane (Sn)	●	●	●											●								●	●	●	●	●	●			
carbathiin-thiram-lindane (Du)	●	●	●	●	●									●	●	●					●	●	●	●	●	●	●			
carbathiin-thiram-lindane (Su)	●		●						●		●			●								●	●	●	●	●	●	●		
fenaminosulf (Wp)													●																	
maneb-lindane (Du)	●	●	●	●										●								●	●	●	●					
iprodione, lindane (Su)									●																			●		

INDEX OF SEED TREATMENTS LISTED IN TABLE 2

CHEMICAL	FORMULATION	PRODUCT NAME
Benomyl, captan lindane	Su, Du	Gammasan plus
Benomyl, thiram	Wp	Benlate T Benomyl — Thiram Fungicide Seed Dressing
Benomyl, thiram,	Du	Thiralin-Plus
lindane	Du	Ipco Benolin-R Insecticide/ Fungicide Dust
Captan	Su	Chipman Flowable Seed Treatment
	Wp	Captan 75 Seed Protectant
	Su	Captan SP-4 flowable
Captan, diazinon	Wp	Chipman Agrox I.F. Dual Purpose Seed Treatment
Captan, lindane	Du	Drill Box Lindasan Seed Treatment
	Du	Pool Rapeseed and Mustard Seed Treatment
	Du	Chipman Gammasan Drill Box Seed Treatment
Captan, lindane, diazinon	Du	Agrox D-L Plus Insecticide/ Fungicide Drill and Seed Treatment Powder
	Du	Pickseed D-L-C Seed Box Treatment
	Du	Drillbox Diazinon-Lindane Plus Captan Seed Treatment Powder
	Du	DCL Slurry
	Du	Co-op Rapeseed and Mustard Seed Treatment
	Du	Co-op D-L & C Drill Box Seed Treatment
	Wp	Chipman B-3 Dual Purpose Seed Treatment
Carbathiin	Sn	Vitaflo 250
	Sn	Vitavax Solution Seed Protectant
Carbathiin, lindane	Sn	Vitavax Dual Solution
Carbathiin, thiram	Du	Vitavax Powder
	Su	Vitaflo 280, Anchor
Carbathiin, thiram,	Du	Vitavax RS Powder
lindane	Su	Vitavax RS Flowable
	Du	Vitavax Dual Powder Seed Protectant
	Su	Vitaflo DP
Carbofuran	Gr	Furadan CR-10
	Gr	Furadan 5G
Fenaminosulf	Wp	Lesan
Lindane	Wp	Lindane
Maneb	Wp	Agrox NM Drill Box Seed Treatment Powder
	Su	Agrox Flowable Seed Treatment Fungicide
	Du	Pool NM Drill Box Seed Treatment
	Du	Pool Seed Treat Powder
	Wp	Manzate D. Agr. Fung.
	Du	Co-op NM Drill Box Seed Treatment

CHEMICAL	FORMULATION	PRODUCT NAME
Maneb, lindane	Du	Pool NM Dual Purpose Drill Box Seed Treatment Powder
	Su	Mergamma Flowable Dual Purpose Seed Treatment
	Du	Pool Dual Purpose Seed Treatment
	Du	Mergamma NM Drill Box Dual Purpose Seed Treatment
	Du	Co-op NM Dual Purpose Seed Treatment
Mancozeb	Wp	Dithane M-45 Seed Protectant
	Wp	Manzate 200 Mancozeb Fungicide
Metiram	Wp	Polyram Dust (Metiram)
	Su	Polyram 7 Fungicide Seed Protectant
Terbufos	Gr	Counter 5G
Thiram	Su	Gustafson 42-S Thiram Fungicide
	Wp	Thiram 75 WP Wettable Powder Fungicide
	Su	Thiram 320 Flowable Fungicide
	Wp	Thiram 75-Wp
	Wp	Pfizer Thiram 75 Seed Fungicide Du
Iprodione, L ...ane	Su	Rovral ST

Weed Control

Recommendations on weed control must be combined with proper identification of the problem, good cultural practices and crop rotations. Refer to the Manitoba Agriculture's Guide to Chemical Weed Control and Field Sprayers publications.

For further information consult your agricultural representative, weed or crop specialist with Manitoba Agriculture, the Plant Science Department, University of Manitoba; Agriculture Canada, the local weed supervisor or chemical industry technical and sales representatives.

Guidelines for Successful Weed Control

- Clean, repair and calibrate the sprayer early in the season.
- Check the crop weekly, after emergence, to identify the weed problem.
- Use the correct herbicide.
- Apply herbicides at the proper stage for maximum weed control and crop safety.
- Use Amine formulations of 2,4-D or MCPA for greater crop safety and to reduce the volatility hazard.
- Avoid spraying on windy days, particularly near susceptible crops.
- Always read and follow herbicide label instructions.
- Do not mix the chemicals unless stated on the label.
- Mix the herbicide solution in the spray tank for 15 minutes before starting to spray by using the sprayer by-pass to circulate through the tank. The spray pump must have sufficient capacity to continue circulation through the by-pass during the spray operation.

Herbicide Residues

Several recommended herbicides will leave a residue in the soil which may restrict cropping options for one or more years after application. See the Manitoba Agriculture Guide to Chemical Weed Control, and the Crop Rotation Chart, and product labels for detailed information.

Insect Pests

Information on control of insect pests of field crops and stored grain can be obtained from these bulletins:

- Field Crop Insects and Their Control, Manitoba Agriculture
- Control of Insects and Mites in Farm Stored Grain, Manitoba Agriculture
- Grasshopper Control in Manitoba, Manitoba Agriculture

Questions about other insects which may cause problems should be referred to Manitoba or Agriculture Canada staff.

TABLE 3 — INSECT PESTS

Information on the control of insect pests listed in the following table may be obtained from the Manitoba Agriculture publication Insect Control in Field Crops (Agdex 622).

Grasshoppers.
Crops attacked: All crops.
Threshold level: Cereal and oilseed crops — 7-12/$M^{2\ (YD2)}$
Cultural control: Fall tillage may destroy some eggpods in fields.

Aphids.
Crops attacked: Cereal crops, flax, faba beans, peas, potatoes.
Threshold levels: Barley (prior to heading) — 50/Plant.
All cereals (after heading) — 50/Head.
Peas — 2-3 aphids/20 CM (8 in.) plant tip at flowering.
Faba beans — When 75% of the plants have at least one aphid.
Potatoes — When numbers exceed 30/100 leaves.
Cultural control: none.

Cutworms.
Crops attacked: Al crops.
Threshold levels: Cereal crops, Oilseeds, sunflowers — 3-4/$M^{2\ (YD2)}$
Cultural contro'. None.

Armyworms.
Crops attacked: Cereal crops.
Threshold level: 10/$M^{2\ (YD2)}$
Cultural control: None.

European Corn Borer.
Crops attacked: Field corn.
Threshold level: When 50% of the plants show shotholing in the leaf whorls.
Cultural control: None.

Bertha Armyworm.
Crops attacked: Canola, mustard, flax.
Threshold level: Canola, mustard — 20-30/$M^{2\ (YD2)}$
Cultural control: None.

Flea Beetles.
Crops attacked: Canola, mustard.
Threshold level: When 25% of leaf surface of seedling plants is destroyed.
Cultural control: None.

Diamondback Moth.
Crops attacked: Canola, mustard.
Threshold level: 30/0.1$M^{2\ (ft2)}$
Cultural control: None.

Sugarbeet Root Maggot.
Crops Attacked: Sugarbeets.
Threshold level: Not available.
Cultural control: Crop rotation, early seeding.

Colorado Potato Beetle.
Crops attacked: potatoes.
Threshold level: When leaf damage exceeds 10%.
Cultural control: None.

Potato Leafhopper.
Crops attacked: potatoes.
Threshold level: When numbers exceed 30/100 leaves.
Cultural control: None.

Sunflower Beetle.
Crops attacked: Sunflowers.
Threshold level: Adults — 1 beetle per 2 seedling plants.
Larvae — when populations exceed 10-12/plant.
Cultural control: none.

FERTILIZER USE

Most crops respond well to fertilizer when the available nutrient level of soil is low. Stubble fields are usually low in nitrogen and phosphorous. Fallow fields usually have adequate nitrogen but are low in phosphorous. Many fields may be low in sulphur and some may also be low in potassium. On the other hand, where high rates of fertilizer have been used for a number of years the level of available nutrients may be adequate to meet crop requirements.

The recommendations for maximum fertilizer rates which can safely be applied with the seed have been established with granular fertilizers using double disc drill seeding equipment. Using this method, fertilizer is placed close to the seed. Discers, hoedrills and air seeders vary in their ability to accurately place seed and fertilizer. Use discretion in increasing recommended maximum rates of fertilizer with the seed if the contact between fertilizer and seed is less than that obtained with a double disc drill. The safe rate of fertilizer applied with the seed may also increase if fertilizer is applied in solution, rather than as granular fertilizer.

Soil Testing

For specific recommendations on individual fields, have your soil analyzed. Obtain details of sampling procedures from your agricultural representative's office or your fertilizer dealer. Cost of routine testing ranges from $8 to $16 depending on test required. Send your sample to:

Provincial Soil Testing Laboratory
Ellis Building
University of Manitoba
Winnipeg, Manitoba R3T 2N2

For further details see Manitoba Agriculture factsheet Soil Testing Services in Manitoba.

Major Nutrients For Annual Crop Production

Nitrogen Nitrogen fertilizer is effective in increasing both yield and protein content. Application at a rate of 75 kg/ha (67 lb/acre) or less to soils low in available nitrogen usually results in yield increases. When soil available nitrogen levels are high or more thn 60 kg/ha (54 lb/acre) nitrogen is applied, both yield and protein content are increased.

The effectiveness of nitrogen in increasing yield and/or protein content is significantly affected by the time of application and method of placement. The various nitrogen carriers are about equally effective in increasing yields and/or protein content of annual crops when applied in a manner that minimizes nitrogen losses. The greatest efficiency of all nitrogen fertilizers is obtained when the fertilizers are banded into the soil at or near seeding, or applied in the seed row.

NOTE: The amounts of various nitrogen fertilizers which can be applied with the seed without seedling damage are given with the fertilizer recommendations for each crop. Urea and liquid or dry fertilizers containing urea should be well covered with soil to minimize losses. Apply anhydrous ammonia and aqua ammonia at depths of 10 to 15 cm (4 to 6 in) and apply only when soil conditions permit a good seal behind the applicator shanks.

Relative Efficiencies of Time and Method of Nitrogen Application

The relative efficiency of nitrogen fertilizers as affected by the time of application and the method of placement varies greatly from year to year. Average relative values of times and methods of application when spring broadcast nitrogen is given a value of 100, has been calculated as follows:

Time and Method	Relative Values
Spring broadcast	100
Spring banded	120
Fall broadcast	82
Fall banded	93

Losses of nitrogen due to leaching, gaseous loss, immobilization and weed growth are probably higher for fall applied than for spring applied nitrogen. This accounts for the differences in efficiencies between fall and spring indicated above.

These losses may be greater if the nitrogen is applied too early in the fall (prior to mid September) or when soil temperatures at the 10 cm (4 in) depth are greater than 5°C.

For further details see Manitoba Agriculture factsheet Nitrogen Fertilization in Crop Production.

Phosphorous Most Manitoba soils are phosphorous deficient and so give yield responses to fertilizer phosphorous application. The response to phosphorous by any crop is affected by factors such as:

- root development and distribution
- ability of the plant to take up soil and fertilizer phosphorous
- the method of phosphorous application
- the soil available phosphorous level
- soil type (soil texture, pH and carbonate content)
- soil water and temperature

Ideally, plants need a good supply of phosphorous close to the seed during the first month of growing and an adequate quantity of phosphorous in the soil for the rest of the season.

Placing sufficient quantities of phosphorous with the seed or close to the seed have been the traditional methods for phosphorous fertilizing annual crops in Manitoba. This has been found to satisfy both early growth

requirements and provide a reserve of phosphorous for the balance of the growing season.

Increasing the amount of phosphorous applied annually above that normally recommended (banded or broadcast) will increase the soil available phosphorous. It could be increased to high or very high levels so that yields would not be significantly affected by deficiency. The number of applications or years of phosphorous fertilization required to increase soil available phosphorous to high or very high levels is unknown for most soils. Soil testing at regular intervals is a good way to monitor the level.

CAUTION: High rates of applied fertilizer phosphorous (annual rates in excess of 150 kg/ha (134 lb/acre) P_2O_5 may induce a micro-nutrient deficiency if soil levels of micro-nutrients are marginal (for example, zinc and copper).

Phosphorous Banded With The Seed Banding of fertilizer phosphorous with the seed results in the greatest yield increase per unit of phosphorous for all crops providing the amount applied is not injurious to the germinating seedling. Crops such as cereals will tolerate all their fertilizer phosphorous requirements placed with the seed.

Phosphorous Banded Near The Seed Banding fertilizer phosphorous near the seed (beside and/or below) results in the greatest yield increase per unit of phosphorous when amounts in excess of those tolerated with the seed are required. Phosphorous placed in this manner is recommended for most oilseeds, annual legumes and row crops.

Phosphorous Deep-banded Deep-banded phosphorous [phosphorous banded at the 10 to 15 cm (4 to 6 inches) soil depth and in spacings of 30 cm (12 inches) or less prior to seeding] is more effective in increasing yields than phosphorous broadcast and incorporated. Nitrogen applied with the phosphorous will increase fertilizer phosphorous availability. Band these fertilizers together when both nitrogen and phosphorous are needed. Application of 10 to 15 kg P_2O_5/ha (9 to 13 lb/acre) with or near the seed may also be required to ensure adequate supplies of phosphorous for early growth.

NOTE: Take care not to disturb the bands during tillage and seeding operations.

Phosphorous Surface Applied and Incorporated Surface incorporation of fertilizer phosphorous results in the lowest yield increase per unit of phosphorous. The amount broadcast must be greater than the amount applied with or near the seed to obtain equal yield increases in the year of fertilizer application. Since the amount of broadcast phosphorous used during the first number of years has to be increased two or fourfold to equal yield increases from placement near the seed, broadcast application of phosphorous may be uneconomic on many soils.

Additional information is contained in the Manitoba Agriculture factsheets Phosphorous Fertilization in Crop Production and Phosphorous Application for Annual Crops.

Potassium Most Manitoba soils contain sufficient available potassium for crop production. Soils likely to contain insufficient potassium are the coarse textured (sands to sandy loams) and organic soils. Additional potassium may be required on about five to seven per cent of arable Manitoba soils for maximum production of the commonly grown annual crops such as cereals, rapeseed, and flax; on 25 to 40 per cent of soils for the production of the special annual crops such as corn, potatoes, sugarbeets and the horticultural fruit or vegetable crops. Potassium where required, can increase crop yield and quality. Depending on the type of crop, it may increase frost and disease resistance, palatability, storage, quality, etc. A soil test is recommended to determine whether a potassium application is warranted in any specific situation.

Within limits allowable for each crop, place potassium fertilizers in the seed row or side band whenever possible for the most efficient use of fertilizer by annual crops. The method and amount of potassium application for specific crops are given with the general fertilizer recommendations for each crop. The efficiency of broadcast potassium is one-half or less of that applied with the seed or side-band. If potassium is being broadcast, the rate recommended for seed placement or side banding should be doubled to obtain equal crop response. If broadcast, incorporate potassium fertilizer into the soil.

Sulphur Well drained sandy soils and grey luvisol (grey wooded) soils are frequently sulphur deficient. Sulphur deficiency may occur in many other soils and in any area of the province. Because of this a soil test is recommended to establish the available sulphur status of your fields.

Crops vary greatly in their sulphur requirements. Canola (Rapeseed), mustard, corn, potatoes, sugarbeets, horticultural crops, and forages containing a legume component have a higher sulphur requirement than cereal grains or flax.

Sulphur deficiencies are more likely to occur in crops having a high sulphur requirement. These crops also have a greater tendency to deplete the sulphur for subsequent crops. This is particularly true following breaking of a perennial forage stand.

Sulphur fertilizer recommendations are based on sulphur being applied in the sulphate (SO_4) form since it is the only form readily available to plants. Some nitrogen and phosphorous fertilizers contain sulphate sulphur; for example, 21-0-0 (24S) 16-20-0 (14S).

Sulphur in the elemental form, as it occurs in some high analysis sulphur products such as flaked or prilled elemental sulphur (99% S), flowers of sulphur (99% S) or granular sulphur (90% S) is not available to plants until oxidized to the sulphate form.

Oxidation of sulphur requires time, and depends on soil temperature and moisture, size of sulphur granules and the rate at which granules break down in the soil. Recent research has found that sulphur from these products does not become available in sufficient quantities to meet crop requirements in the year of application. Therefore, they are not recom-

mended to be applied on soils with a low available sulphur content where the crops would require the applied sulphur to be available in the immediate year of application.

Ammonium thiosulphate, 12-0-0 (26), is a liquid formulation containing 26 per cent sulphur by weight. One-half of the sulphur converts into the readily available sulphate form and the remainder into finely divided elemental sulphur. This product can be applied to supply sulphur at the rate recommended for sulphate sulphur.

Micro-Nutrients

The majority of mineral soils in Manitoba contain sufficient micro-nutrients for most crops. Farmers should not apply micro-nutrient fertilizers unless they have established that deficiencies exist through consultation with extension agronomists, a soil analysis, and small scale trials.

The Manitoba Soil Testing Laboratory offers a soil micronutrient analysis service. The cost for a copper-zinc-iron-manganese soil analysis is $7 per field, if in addition to a routine soil test. These tests are performed only when specifically requested. Proper soil sampling and sample handling procedures are important.

Additional information is available in the Manitoba Agriculture factsheet Micro-nutrients in Crop Production.

Plant Tissue Analysis

The Manitoba Soil Testing Laboratory offers a plant tissue analysis service. Plant tissue analysis is useful in evaluating fertilizer management programs and practices, diagnosing nutrient related crop production problems, and identifying nutrient levels in crops that may limit top yield achievement. It is also especially useful in evaluating and identifying potential micronutrient problems.

Cost ranges from about $5.00 per sample for a nitrogen only analysis to about $16.50 for a complete 10 nutrient analysis. Proper plant sampling and sample handling procedures are important. Detailed information on plant tissue analysis and complete instructions for sampling are contained in the Manitoba Agriculture factsheet Plant Tissue Analysis.

Organic Soils

Crops such as barley, oats, canola (Polish type) and grasses perform better than wheat and flax due to the colder micro-climate on organic soils.

Most organic soils are very deficient in phosphorous and potassium. Farmers on organic soils should use the higher rates of phosphate and potassium recommended in this publication for each crop.

Organic soils are frequently deficient in copper and may also be deficient in manganese and boron. Use both soil and plant analyses as aids in determining if these micro-nutrients are deficient. Conduct small scale trials (micro-nutrients applied to portions of a field) to assess the effects of micro-nutrient fertilizers on crop yields before using large areas. Recommendations for micro-nutrient fertilizer use in these trials and in instances where deficiencies exist are:

Copper: Apply five to 15 kg/ha (four to 13 lb/acre) copper, (for example, 20 to 60 kg/ha (18 to 54 lb/acre) copper sulphate). Spray dissolved copper sulphate and incorporate well into the top 15 cm (6 in) of soil. Research indicates that applying copper fertilizer in the solution form is superior to its application in granular form. After soils have been fertilized two or three times with copper, have both a soil and a plant analysis to determine if excessive copper accumulation has occurred. ***Caution:*** The use of a standard sprayer (minimum agitation and roller pumps) is not recommended for the application of copper sulphate. Intense continuous agitation is needed to keep copper sulphate in suspension. A high capacity centrifugal pump should be used to avoid wear problems and provide the necessary tank agitation.

Manganese: 10 to 15 kg/ha (9 to 13 lb/acre) manganese, (for example, 40 to 60 kg/ha (36 to 54 lb/acre) manganese sulphate) should be drilled with the seed of cereals and banded away from the seed of rapeseed and grasses.

Boron: Incorporate 1 to 2 kg/ha (1 to 2 lb/acre) boron, (for example, 9 to 17 kg/ha (8 to 15 lb/acre) borax) with the surface 15 cm (6 in) of soil.

Additional information is contained in the Manitoba Agriculture factsheet Micro-nutrients in Crop Production.

Calculation of Fertilizer Rates Fertilizers are labelled by percentage according to their guaranteed minimum analysis in terms of nitrogen (N), phosphate (P_2O_5) and potash (K_2O). For example, 16-20-0 (14) contains 16 per cent nitrogen by weight, 20 per cent phosphate by weight, 0 per cent potash by weight, and approximately 14 per cent sulphur by weight. The actual weight of nutrients in 100 kg (220 lb) fertilizer is: N = 16 kg, (35 lb), P_2O_5 = 20 kg (44 lb) and K_2O = 0.5 kg, (1.1 lb.) and S = 14 kg (31 lb) approximately.

For example:

1. Using 34-0-0
   Rate of N desired = 45 kg/ha (40 lb/acre)

$$\text{Rate of fertilizer required} = \frac{45 \times 100}{34} = 132 \text{ kg/ha}$$

$$= \frac{(40 \times 100)}{(34)} = (117 \text{ lb/acre})$$

2. Using 16-20-0-14
   Rate of P_2O_5 desired = 22 kg/ha (20 lb/acre)

$$\text{Rate of fertilizer} = \frac{22 \times 100}{20} = 110 \text{ kg/ha}$$

$$= \frac{(20 \times 100)}{(20)} = (100 \text{ lb/acre})$$

   110 kg/ha (100 lb/acre) of 16-20-0(14) would also supply nitrogen at the rate of

$$\frac{16 \times 110}{100} = 17.6 \text{ kg/ha} \; ; \; \frac{(16 \times 100)}{(100)} = (16 \text{ lb/acre})$$

   and sulphur at the rate of

$$\frac{14 \times 110}{110} = 15.4 \text{ kg/ha} \; ; \; \frac{(14 \times 100)}{(100)} = (14 \text{ lb/acre})$$

Additional information is contained in the Manitoba Agriculture fact-sheet "Calculating Nutrient Costs and Fertilizer Rates".

TABLE 4 — COMMON FERTILIZERS

NOTE: The number in brackets denotes the approximate percentage of sulphur in the fertilizer.

	Liquids (solutions)
Ammonium phosphate	10-34-0
Nitrogen solution	28-0-0
Aqua ammonia	20-0-0
Ammonium thiosulphate	12-0-0-(26)
	Gas (compressed)
Anhydrous ammonia	82-0-0
	Dry (solids)
Ammonium phosphate	11-51-0 to 11-55-0
Ammonium phosphate sulphate	16-20-0(14)
Diammonium phosphate	18-46-0
Ammonium nitrate phosphate	24-22-0, 28-13-0
Urea ammonium phosphate	27-27-0; 34-17-0
Ammonium sulphate	21-0-0-(24)
Ammonium nitrate phosphate sulphate	26-13-0(3)
Ammonium nitrate	34-0-0
Urea-ammonium sulphate	34-0-0(11)
Urea Sulphur (elemental)	36-0-0(20)
Urea	46-0-0
Potassium chloride	0-0-60; 0-0-62
Potassium sulphate	0-0-50(18)
Calcium sulphate (Gypsum)	0-0-0(13 to 19)
Sulphur (clay base)	0-0-0(90)

In addition to these premixed fertilizers, micro-nutrients and specially blended fertilizers including suspensions are available from some fertilizer dealers.

Erosion Control

Sufficient crop residue must be left on the surface of the soil to prevent erosion during the crucial period when there is insufficient crop growth to provide adequate protection.

Table 5 indicates the amount of various crop residues for different soil textures required for wind erosion protection.

TABLE 5 — CROP RESIDUE REQUIREMENTS FOR WIND EROSION CONTROL

	kg/ha (lb/acre)			
Texture	**Small Grains (flat straw)**	**Grain Corn, Sunflower (standing stalks)**	**Canola, Flax (standing straw)**	**Grain Corn (flat straw)**
very fine, fine & medium sands, dune sands	1900-2200 (1700-2000)	2800-3400 (2500-3000)	3200-3900 (2900-3500)	4600-5600 (4100-5000)
loamy sands, loamy fine sands	1200-1600 (1100-1400)	1900-3400 (1700-2100)	2300-2700 (2100-2400)	3400-3900 (3000-3500)
very fine sandy loams, fine sandy loams, sandy loams	1000-1300 (900-1200)	1100-1600 (1000-1400)	1800-2200 (1600-2000)	2500-3100 (2200-2800)
clay, silty clays, non-calcareous clay loams & silty clay loams	700-1100 (600-1000)	900-1800 (800-1600)	1200-2000 (1100-1800)	1700-3100 (1500-2800)
calcareous loams & silt loams, calcareous clay loams & silty clay loams non-calcareous loams, silt loams, sandy clay loams & clay loams	200-560 (200-500)	450-780 (400-900)	450-1000 (400-900)	900-1300 (800-1200)

For water erosion control, Table 6 shows the recommended residue requirements according to per cent slope.

TABLE 6 — SLOPE AND RECOMMENDED QUANTITY OF RESIDUE

% Slope	**Description**	**Residue** kg/ha (lbs/acre)**
6 - 9	gentle slopes	780 - 110 (700 - 1000)
10 - 15	moderate slopes	1100 - 1700 (1000 - 1500)
16 - 30	steep slopes	continuous grass and forage
+30	very steep slopes	native vegetation

**Refers to annual crops.

The amount of crop residue which is left to cover the soil surface after fall tillage also affects soil moisture. As a general rule, the moisture content of a soil will increase as more residue is left on the surface. The

residue absorbs the force of the rain drops and as a result reduces surface crusting and thereby maintains a greater infiltration rate for the rainwater. It also reduces the loss of soil water by evaporation and traps snow in the winter.

Tillage is one farming practice which has a direct influence on the amount of residue left on the soil surface to combat erosion and build up soil moisture reserves. Use of tillage equipment buries crop residue and reduces its effectiveness in soil and water conservation. Table 7 shows the amount of trash buried by various tillage implements.

TABLE 7 — EFFECT OF SEVERAL TYPES OF TILLAGE IMPLEMENTS ON RESIDUE COVER

Implement	Amount Of Straw Buried With Each Pass %*
Wide Blade Cultivator [sweeps 95 cm (37 inches) or wider]	10
Rodweeder	10
Field Cultivator	10 - 20
Heavy Duty Cultivator	20 - 30
One-Way Disc	40 - 50
Heavy Tandem or Offset Disc	35 - 65
Plow	90

*Residue reduction will vary depending on depth of operation and speed of travel.

Minimum Tillage

Minimum tillage refers to the least amount of tillage operations required to create the proper soil conditions for seed germination and plant establishment. Minimum tillage can be considered conservation tillage if sufficient crop residues are left on the soil surface to provide erosion protection.

Zero Tillage

Zero tillage crop production involves the planting of a crop into untilled stubble land with minimal soil disturbance and if necessary, chemical weed control.

Research trials and farmer experience have shown that zero tillage provides an alternate method of production for wheat, barley, flax, and rapeseed where tillage reduction is desirable to conserve moisture, reduce soil erosion, reduce fuel and labor inputs, and reduce numbers of annual weeds. Zero tillage can be practised on most soil types. However, wet heavy clay soils may cause difficulties in seeding resulting in inadequate crop stands.

Field experience has shown that trash management and fall weed control are extremely important the fall before zero tillage crop production.

Continuous cropping with the same crop can lead to a build-up of soil-borne diseases, so a crop rotation is recommended. Zero tillage may result in an increased risk of diseases that are partially controlled by incorporating the stubble.

These operations are included in zero tillage crop production.

Fall

1. Crop Residue Management Straw and chaff must be removed or chopped and evenly distributed in the fall to allow for proper seed placement.

2. Weed Control Perennial weeds (quackgrass, Canada thistle and perennial sow thistle) and winter annual weeds (stinkweed, shepherd's purse, and flixweed) must be controlled in the fall.

3. Soil test A soil test is required to accurately determine fertility requirements.

Spring

1. Fertility Fertilize zero tillage crops according to soil test recommendations. Place maximum allowable amounts with the seed. The remaining nitrogen should be broadcast. Granular fertilizer is preferred to solution nitrogen for broadcast application, especially under dry conditions.

2. Seeding Seed should be placed 2 to 3 cm (0.8 to 1.2 in) into moisture using a modified press drill or a commercial zero tillage drill. Minimize soil disturbance to avoid unnecessary weed germination.

3. Initial Weed Control All weed growth present at the time of seeding must be controlled. The herbicide can be applied prior to seeding or between seeding and crop emergence. Application before seeding eliminates the risk of weather delaying spraying past crop emergence. Application after seeding, but prior to crop emergence, maximizes weed control by allowing more weeds to emerge.

4. Weed Control In The Crop Selective weed control in the crop depends on postemergent herbicides. Crops which cannot be treated with postemergent herbicides should not be considered for zero tillage.

Specific weed control recommendations can be obtained from the Guide to Chemical Weed Control.

Variety Recommendations and Descriptions

For variety recommendations and descriptions for all crops see a copy of the Manitoba Agriculture Field Crop Variety Recommendations publication.

CEREAL CROPS

BARLEY

Seeding

Dates May 1 to May 31. On the average, highest barley yields and optimum quality are obtained when the crop is planted early. Planting in late May or early June can result in significant yield reductions.

Rates 65 to 120 kg/ha (1.25 to 2.25 bu/acre). Circumstances requiring heavier rates of seeding include reduced germination, large seed size, abundant moisture reserves, and rough land preparation. The seeding rate for 2-rowed barley varieties should be increased by 25 per cent because of kernel size.

Depth 4 to 5 cm (1.5 to 2 inches). Sow seed deep enough to reach moisture. Deep seeding weakens the plants and may result in poor emergence.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Place all phosphate, potash, and nitrogen when possible, in the seed row for most efficient use of the fertilizer. Total seed-placed fertilizer should not exceed 195 kg/ha, (174 lb/acre). Up to 45 kg/ha, (40 lb/acre) nitrogen; not more than 20 kg/ha (18 lb/acre) nitrogen in urea form, may be placed with the seed.

Urea or urea-P should not be placed with the seed on coarse textured soils nor with the seed on any soil under dry seedbed conditions. Place any additional fertilizer required away from the seed. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)[1]		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Barley to be grown on	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	0-30	0-27	30-45	27-40	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	30-60	27-54	30-45	27-40	(3)	(3)	(4)	(4)
Stubble	60-100	54-89	30-45	27-40	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 15 to 35 kg/ha (13 to 31 lb/acre) of potash (K_2O).

(4) Low sulphur levels can occur in any Manitoba Soil. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information on the application of different forms of sulphur fertilizer, see page 19.

Potential Insect Pests

Grasshoppers, aphids, cutworms, armyworms are potential barley insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Smuts Treat seed of varieties listed as having fair resistance to loose or surface borne smuts (covered and false loose) with a suitable fungicide every three years. Varieties with poor resistance should be treated every two years. See Table 2.

Leaf Spots Fungi which cause leaf spot diseases of barley overwinter on barley straw, stubble, and seed. Treat seed from infected fields to reduce seedling infection. Planting barley after barley enhances the potential severity of net blotch and spot blotch, particularly in younger plants. See Table 1 for more information.

Ergot If ergot has been a problem, rotate with a non-susceptible crop for one year to reduce disease incidence (see Table 1). Cultivate fields after harvest to bury ergot bodies to a depth of at least 5 cm (2 inches) and mow grass headlands and roadsides before heading to reduce ergot spread. If the seed source is known to contain ergot bodies, storage for more than one year reduces their viability to almost zero. Levels of ergot bodies in the harvested grain above 0.1 per cent may be toxic in livestock feed.

Harvesting

Particular care must be taken when harvesting malting barley, otherwise a promising standing crop of malting barley may end up in the feed grades. Give close attention to the following:

- To promote fast drying, swath in compact windrows laid on stubble about one-third the height of the standing crop. The head should not come in contact with the ground.
- Adjust the combine several times during the day if necessary to prevent cracking and peeling. This generally means a slower cylinder speed than used for wheat, oats, or feed barley. Have the concave clearance adjusted to suit conditions; wider clearances are usually required at midday when the grain is driest.
- Avoid using damaged grain augers and elevators which can cause broken and peeled kernels.

- Highest yields are obtained when swathing is done with a kernel moisture content of about 35 per cent. Then the kernels are firm but easily dented with the thumb nail.

OATS

Seeding

Dates May 1 to June 10. Oats give best returns when sown early.

Rates 55 to 115 kg/ha (1.5 to 3 bu/acre). Circumstances requiring heavier rates of seeding are large seed size, low germination, late seeding, weeds, wireworms, abundant moisture reserves, heavy textured soils, high soil fertility, deep seeding, and rough seedbed.

Depth 4 to 7 cm (1.5 to 3 inches).

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Place all phosphate, potash and nitrogen when possible, in the seed row for most efficient use of the fertilizer. Total seed-placed fertilizer should not exceed 195 kg/ha (174 lb/acre). Up to 45 kg/ha (40 lb/acre) nitrogen, not more than 20 kg/ha (18 lb/acre) nitrogen in urea form, may be placed with the seed. Urea or urea-P should not be placed with the seed on coarse textured soils nor with the seed on any soil under dry seedbed conditions. Place any additional fertilizer required away from the seed. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)(1)		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Oats to be grown on	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	0-30	0-27	30-45	27-40	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	30-60	27-54	30-45	27-40	(3)	(3)	(4)	(4)
Stubble	60-100	54-89	30-45	27-40	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 15 to 35 kg/ha (13 to 31 lb/acre) of potash (K_2O).

(4) Low sulphur levels can occur in any Manitoba soil. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information on the application of different forms of sulphur fertilizer, see page 19.

Potential Insect Pests

Grasshoppers, aphids, cutworms, armyworms are potential oat insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Early seeding and heavier seeding rates will reduce damage by barley yellow dwarf virus.

Harvesting

Highest yields are obtained by swathing when the kernel moisture content is about 35 per cent. The greenest kernels (groats) at this stage have just changed from green to cream coloured. To obtain highest milling grades, dehulled kernels must be avoided. This may involve slower cylinder speed and wider concave clearances.

RYE

Seeding

Dates Fall Rye — August 25 to September 15
Spring Rye — May 1 to May 30

Rates 45 to 95 kg/ha (0.75 to 1.5 bu/acre). High rates of seeding should be used with larger seed size, poor germination, weed competition, and poor seedbed conditions.

Depth 2.5 to 5 cm (1 to 2 inches). Do not plant rye deeper than necessary to assure contact with moist soil. Deeper seeding may result in decreased emergence and weak plants causing severe winter kill in fall-seeded varieties.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 in) and 15 to 60 cm (6 to 24 in).

Place all phosphate, potash, and nitrogen when possible, in the seed row for most efficient use of the fertilizer. Total seed-placed fertilizer should not exceed 195 kg/ha (174 lb/acre). Up to 45 kg/ha (40 lb/acre) nitrogen, not more than 20 kg/ha (18 lb/acre) nitrogen in urea form, may be placed with the seed. Rates of nitrogen above those than can be safely applied with the seed should be broadcast in the spring. Urea or urea-P should not be placed with the seed on coarse textured soils or with seed on any soil under dry seedbed conditions. Place any additional required fertilizer away from the seed. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

Rye to be grown on	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)(1)		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	0-20	0-18	30-45	27-40	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	20-45	18-40	30-45	27-40	(3)	(3)	(4)	(4)
Stubble	45-70	40-62	30-45	27-40	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast in the spring. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 15 to 35 kg/ha (13 to 31 lb/acre) of potash (K_2O).

(4) Low sulphur levels can occur in any Manitoba Soils. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information on the application of different forms of sulphur fertilizer, see page 19.

Potential Insect Pests

Grasshoppers, aphids, cutworms, armyworms are potential rye insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Seed Rot and Seedling Blights Rye seed should be treated with a suitable treatment product to reduce seed rot, seedling blights and stem smut. See Table 2 for additional information.

Ergot For ergot problems, rotate with a non-susceptible crop for one year to reduce incidence (see Table 1). Cultivate fields following harvest to bury ergot bodies to a depth of at least 5 cm (2 inches) and mow grass headlands and roadsides before heading to reduce spread. If the seed source is known to contain ergot bodies, storage for more than one year will reduce their viability to almost zero. Levels of ergot bodies in the harvested grain above 0.1 per cent may be toxic in livestock feed.

TRITICALE

Seeding

Dates April 15 to May 15. Triticale must be sown as early as possible for maximum yields.

Rates 125 kg/ha — 185 kg/ha (2 to 3 bu/acre) depending on seed size.

Depth 5 cm (2 inches). Triticale should not be placed deeper than necessary to assure contact with moist soil. Decreased emergence and weaker plants may result from deeper seeding.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 in) and 15 to 60 cm (6 to 24 in).

Place all phosphate, potash, and nitrogen when possible, in the seed row for most efficient use of the fertilizer. Total amount of seed-placed fertilizer should not exceed 195 kg/ha (174 lb/acre). Up to 45 kg/ha (40 lb/acre) nitrogen; not more than 20 kg/ha (18 lb/acre) nitrogen in urea form, may be placed with the seed.

Do not place urea or urea-P with the seed on coarse textured soils nor with the seed on any soil under dry seedbed conditions. Place any additional fertilizer required away from the seed. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)(1)		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Triticale to be grown on	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	0-20	0-18	30-45	27-40	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	20-45	18-40	30-45	27-40	(3)	(3)	(4)	(4)
Stubble	45-70	40-62	30-45	27-40	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast in the spring. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 15 to 35 kg/ha (13 to 31 lb/acre) of potash (K_2O).

(4) Low sulphur levels can occur in any Manitoba Soils. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information on the application of different forms of sulphur fertilizer, see page 19.

Potential Insect Pests

Grasshoppers, aphids, cutworms, armyworms are potential triticale insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Ergot Triticale is slightly more susceptible to ergot than wheat. If this is a problem, rotate with a non-susceptible crop for one year to reduce incidence (see Table 1). Cultivate fields following harvest to bury ergot bodies at least 5 cm (2 inches). Mow grass headlands and roadsides before heading to reduce spread. If the seed source contains ergot bodies, storage for more than one year reduces their viability to almost zero. Ergot body levels in the harvested grain above 0.1 per cent may be toxic in livestock feed.

Special Notes

Tritricale is a new crop species still limited in its adaptation. Growers are advised to test it initially on a small scale before seeding larger acreages. Grain grades have now been established to facilitate marketing.

Tritricale is more susceptible to sprouting in the swath than varieties of Hard Red Spring Wheat. Straight combining is advisable since it has been successful in minimizing sprouting damage.

WHEAT

Seeding

Dates May 1 to May 31. Start seeding as early in spring as soil conditions permit. Any delay may result in lower yields.

Rates 65 to 135 kg/ha (1 to 2 bu/acre). Conditions favouring heavier rates of seeding are large seed size, low germination, late seeding, weeds, wireworms, abundant moisture, heavy textured soils, high fertility, deep seeding, and rough seedbed. Durum wheat should be seeded at the higher rate because of its large seed size.

Depth 4 to 8 cm (1.5 to 3 in). Plant seeds only deep enough to reach moisture. Deep seeding weakens the plants and may result in poor emergence and lower yields.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 in) and 15 to 60 cm (6 to 24 inches).

Place all phosphate, potash, and nitrogen when possible, in the seed row for most efficient use of the fertilizer. Total seed-placed fertilizer should not exceed 195 kg/ha (174 lb/acre). Up to 45 kg/ha (40 lb/acre) nitrogen; not more than 20 kg/ha (18 lb/acre) nitrogen in urea form, may be placed with the seed.

Urea or urea-P should not be placed with the seed on coarse textured soils nor with the seed on any soil under dry seedbed conditions. Place any additional fertilizer required away from the seed. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
Wheat to be grown on	Nitrogen (N)(1) kg/ha	Nitrogen (N)(1) lb/acre	Phosphate (P_2O_5) kg/ha	Phosphate (P_2O_5) lb/acre	Potash (K_2O) kg/ha	Potash (K_2O) lb/acre	Sulphur (S) kg/ha	Sulphur (S) lb/acre
Fallow or legume breaking (2)	0-30	0-27	30-45	27-40	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	30-60	27-54	30-45	27-40	(3)	(3)	(4)	(4)
Stubble	60-100	54-89	30-45	27-40	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 15 to 35 kg/ha (13 to 31 lb/acre) of potash (K_2O).

(4) Low sulphur levels can occur in any Manitoba soil. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information on the application of different forms of sulphur fertilizer, see page 19.

Nitrogen Fertilization and Protein Content High protein wheat can be grown in all areas of Manitoba if sufficient nitrogen is available to the plant from the soil or from nitrogen applied as fertilizer. As the nitrogen supply is increased from low to high, an increase in yield results first, followed by an increase in both yield and protein content. Wheat protein content is about 13.2 to 13.5 per cent when sufficient nitrogen is present for near maximum yields. To determine if sufficient nitrogen is present for near maximum yields check the grains protein content. If protein content is less than 13.2 per cent, insufficient nitrogen has been added. When the protein content is more than 13.5 per cent, sufficient nitrogen has been added for near maximum yields. The following table provides guidelines for the amounts of nitrogen fertilizer required to produce wheat of a particular protein content. Average values for soil-available nitrogen are used.

NITROGEN FERTILIZER REQUIRED kg N/ha (lb N/acre)
"Target" Protein Content (%) (1)

	12.5		13.5		14.5	
Wheat Grown On	**Area A(3)**	**Area B(4)**	**Area A**	**Area B**	**Area A**	**Area B**
Fallow or legume breaking (2)	0(0)	0(0)	0(0)	0(0)	30(27)	10(9)
Grass and grass-legume breaking (2)	20(18)	0(0)	60(54)	30(27)	100(89)	80(71)
Stubble	60(54)	35(31)	100(89)	70(62)	140(125)	120(107)

(1) Refers to protein content of Red Spring Wheats.

(2) Refers to breaking after first cut of forage (before June 30).

(3) Area A refers to Zones 3, 3A, 4 and 6.

(4) Area B refers to Zones 1, 2, 2A and 5.

Potential Insect Pests

Grasshoppers, aphids, cutworms, and armyworms are potential winter wheat insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Loose Smut or Bunt Seed of varieties having fair resistance to loose smut or bunt should be treated with a suitable fungicide every three years. Those with poor resistance every two years. See Table 2.

Ergot If ergot has been a problem, rotate with a non-susceptible crop for one year to reduce incidence (see Table 1). Cultivate fields following

harvest to bury ergot bodies to a depth of at least 5 cm (2 inches) and mow grass headlands and roadsides before heading to reduce spread. A seed source known to contain ergot bodies should be stored for more than one year to reduce viability to almost zero. Levels of ergot bodies in harvested grain above 0.1 per cent may be toxic in livestock feed.

Fusarium Head Blight Fusarium head blight can develop in a wheat crop when a lot of infested debris is present on the soil surface and abundant rainfall occurs at heading. Experience in southern Ontario indicates that overwintered debris from infected corn results in the most damage to the subsequent crop. To minimize the risk of fusarium head blight, corn should not precede wheat in the rotation.

Tan Spot Tan spot is becoming more prevalent in spring wheats in Manitoba. All cultivars are susceptible and there are no fungicides registered for its control. The casual organism is a fungus that survives from one year to the next in wheat straw and stubble. Rotations away from wheat for at least one year are recommended to reduce disease severity. Severe outbreaks of tan spot have been found in fields cropped to wheat the previous year.

Harvesting

Experiments show that highest yields are obtained by swathing when the kernel moisture content is about 35 per cent, and that there is no loss in quality, test weight, or seed size. This stage is reached when the kernels are firm but easily dented by the thumb nail. Greenest kernels should show a slight colour change towards yellow or brown.

WINTER WHEAT

Management Practices

Winter wheat production in Manitoba requires that plants are protected from cold winter temperatures. The most effective method of protection is to use zero tillage.

Winter wheat is planted directly into the standing stubble of the previous crop. The standing stubble traps snow on the field which will then act as an insulating blanket to prevent cold temperature killing of winter wheat. The crop preceding winter wheat must provide upright stubble and must be harvested early to allow winter wheat to be planted on time. Barley, canola (particularly Polish types), oats, flax and buckwheat stubble can be used.

Stubble Height

The stubble from a previous cereal or flax crop should be cut at a height of 15-20 cm (6-8 inches) and from a previous canola or buckwheat crop should be cut at a height of at least 30 cm (12 inches) to ensure that at least 15 cm (6 inches) of snow can be maintained. Excessive fall stubble can lead to difficulties in seeding, slow growth in spring and the possibility of snow mould.

Seeding

Dates August 20 to September 15. Optimum date for southern areas of Manitoba is the first week of September, and the last week of August for northern areas. Winter wheat should be planted early enough to ensure that plants have 3 to 4 leaves at freeze-up. Delays in seeding cause late maturity, poor competition with weeds, increased risk of rust infection and lower yields.

Rates 70 to 100 kg/ha (63 to 89 lb/acre). Conditions requiring heavier seeding rates are low germination, late seeding, heavy textured soils, deep seeding, poor drill penetration, abundant moisture, or high fertility.

Depth 1.5 to 3 cm (0.6 to 1.2 inches). Winter wheat should be seeded shallow. Deep seeding late in the season causes a delay in emergence which may result in a poor stand.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Adequate fertility levels are required for optimum winter survival and yield of winter wheat. Although little information on fertilizer rates in zero-till winter wheat has been collected in Manitoba, the yield potential of the crop and information from other areas suggests that winter wheat should produce yield responses to fertilizer rates slightly higher than those used for spring wheat.

If the soil nitrogen level is very low, a small amount of nitrogen fertilizer could be applied at the time of seeding to encourage adequate growth in the fall and spring. Application of the bulk of nitrogen fertilizer should be delayed until early spring, since fall application could lead to decreased nitrogen use efficiency. However, fall banded application of nitrogen may be a relatively efficient application method. If fall nitrogen fertilization is practiced, phosphorous fertility should be maintained at high levels to ensure adequate over wintering. For optimum efficiency, spring nitrogen should be applied prior to the resumption of winter wheat growth. All phosphorous should be placed with the seed, for optimum efficiency and promotion of winter survival.

Sands, sandy loam and organic soils are often low in available potassium. Low sulphur levels can occur in any Manitoba soil. For highest yields, soil test and supply the stand with a balanced fertility supply.

Potential Insect Pests

Grasshoppers, aphids, cutworms, and armyworms are potential wheat insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Follow a crop rotation of at least one year between wheat crops. Avoid other cereal crops in the rotation, to control soil borne diseases.

Rust All varieties of winter wheat are susceptible to stem and leaf rust. In some years severe losses may occur due to rust infection. Losses as high as 40% have been recorded in Manitoba under severe disease conditions.

Tan Spot Winter wheat should not be planted into wheat stubble because of the risk of tan spot which may affect plants the following spring and throughout the season during periods of moist weather.

Loose Smut or Bunt Seed of varieties having fair resistance to loose smut or bunt should be treated with a suitable fungicide every three years. Those with poor resistance every two years. See Table 2.

OILSEEDS AND SPECIAL CROPS

BUCKWHEAT

Seeding

Date June 1 to June 25. Buckwheat is susceptible to late spring and early fall frosts which can cause significant yield reductions. To obtain maximum yields, especially of Mancan, plant before June 10. Northern plantings should be no later than June 15 to avoid early fall frosts.

Rate 40 to 55 kg/ha (¾ to 1 bu/acre)

Depth 4 to 6 cm (1.5 to 2.5 in)

Fertilizer

For specific recommendations, have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Any nitrogen in excess of 7 kg/ha (6 lb/acre) and phosphorous in excess of 20 kg/ha (18 lb/acre) and all potash and sulphur should be placed away from the seed to avoid seed injury. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)(1)		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Buckwheat to be grown on	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**
Fallow or legume breaking (2)	0-20	0-18	(3)	(3)	(4)	(4)	(5)	(5)
Grass and grass-legume breaking (2)	20-45	18-40	(3)	(3)	(4)	(4)	(5)	(5)
Stubble	45-70	40-62	(3)	(3)	(4)	(4)	(5)	(5)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) 30 to 45 kg/ha (27 to 40 lb/acre) of P_2O_5 about 2.5 cm (1 inch) to the side and 2.5 cm (1 inch) below the seed is recommended. No more than 20 kg/ha (18 lb/acre) should be placed with the seed.

(4) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) of potash (K_2O).

(5) Low sulphur levels can occur in any Manitoba soil. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information on the application of different forms of sulphur fertilizer, see page 19.

Potential Insect Pests

Grasshoppers and cutworms are potential buckwheat insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Harvesting

Swath buckwheat when about 75 per cent of the seeds have turned brown. In order to minimize shattering, swath under dewy conditions. In the event of light frost, leave until the normal per cent of seeds have turned brown. If severe frost occurs and stems are frozen, swath promptly to reduce loss from shattering. When combining, a cylinder speed of 600 to 800 revolutions per minute may be used as an initial setting. Seed is considered dry at 16 per cent moisture content.

Special Notes

Buckwheat is a naturally cross-pollinated crop with insects being the main pollinating agents. Increases in yield are usually achieved by establishing colonies of bees near fields of buckwheat.

CANARYSEED

Canaryseed is an annual grass requiring about the same time to mature as wheat. Early May planting is recommended for maximum yield. A seeding rate of 40 kg/ha (35 lb/acre) is recommended, at a planting depth of 3.5 to 5 cm (1.5 to 2 inches).

Canaryseed fertility needs can be determined by soil testing. If soil analysis results are not available, the higher rates recommended for cereal crops may be used. Canaryseed is resistant to shattering and may be direct combined or swathed when fully mature. A maximum of 12 per cent moisture is considered safe for storage (use flax chart in moisture determination). Additional information may be obtained from the publication Canary Grass Seed Production in Manitoba, (Agdex 147), prepared by Manitoba Agriculture, and from the contracting agencies.

Potential Insect Pests

Grasshoppers, aphids, cutworms, and armyworms are all potential canaryseed insect pests. See Table 3 on page 15 for cultural control and threshold level information.

CANOLA — RAPESEED

Seeding

Dates Argentine type — May 5 to May 30
Polish type — May 5 to June 15

Canola should be sown early for uniform ripening, better grade and higher yield. The Argentine type varieties are later maturing and represent a greater risk if grown in areas with a short frost free season. The Polish type varieties are lower yielding but mature earlier and are less likely to sustain frost damage in short-season areas or if seeding is delayed.

Rates Argentine type — 6 to 8 kg/ha (5 to 7 lb/acre)
Polish type — 5 to 7 kg/ha (4 to 6 lb/acre)

Depth 2.5 to 4 cm (1 to 1.5 inches)

Fertilizer

For specific recommendations have your soil tested. Take samples at depths 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Any nitrogen in excess of 7 kg/ha (6 lb/acre) and phosphorous in excess of 20 kg/ha (18 lb/acre) and all potash and sulphur should be placed away from the seed to avoid seed injury. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
Canola-Rapeseed to be grown on	**Nitrogen (N)(1)**		**Phosphate (P_2O_5)**		**Potash (K_2O)**		**Sulphur (S)**	
	kg/ha	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**
Fallow or legume breaking (2)	0-35	0-31	(3)	(3)	(4)	(4)	(5)	(5)
Grass and grass-legume breaking (2)	35-80	31-71	(3)	(3)	(4)	(4)	(5)	(5)
Stubble	80-100	71-89	(3)	(3)	(4)	(4)	(5)	(5)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage

(3) 30 to 45 kg/ha (27 to 40 lb/acre) of P_2O_5 as a sideband application about 2.5 cm (1 inch) to the side and 2.5 cm (1 inch) below the seed is recommended. No more than 20 kg/ha (18 lb/acre) should be placed with the seed.

(4) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) of potash (K_2O).

(5) Twenty kg/ha (18 lb/acre) of sulphate sulphur (S) are recommended on well drained sandy soils and grey luvisol (grey wooded) soils. For information on the application of different forms of sulphur fertilizer see page 19.

Disease Control

Use seed from disease-free fields. Treat seed to control seed rot, seedling blights, and to prevent the introduction and establishment of black leg into black-leg free areas. (See Table 2) Where black leg is already established in an area, seed treatments are ineffective in controlling the disease. Do not sow canola or rapeseed adjacent to canola on rapeseed stubble. To control black-leg and soil borne diseases, follow a crop rotation of at least four years and control volunteer plants, wild mustard and other cruciferous weeds between canola crops. Avoid fababeans, field beans, field peas, forage legumes, lentils, mustard, safflower, soybeans and sunflowers in the rotation because of sclerotinia stem rot. See Table 2. If necessary, sclerotinia stem rot may be controlled by aerial application of

benomyl (Benlate) 1.0-1.5 kg/ha (0.9-1.4 lb/acre) or Iprodione (Rovral) 1.0-1.5 kg/ha (0.9-1.4 lb/acre) at the 20-30 per cent blossom stage. Argentine types are resistant to staghead.

Insect Control

Flea beetles can damage canola and rapeseed crops from early seeding to harvest. Seed treatments with Counter 5 G, Furadan CMIO or lindane are strongly recommended. Observations throughout the entire growing season are necessary to determine if post-emergence sprays are needed. For recommended insecticides see Table 2.

The Bertha army worm has been a serious pest in canola and rapeseed fields in Manitoba. When its numbers exceed 20 to 24/square metre, control measures should be considered. For control recommendations see Table 4, and the Manitoba Agriculture publication Insect Control on Field Crops.

Potential Insect Pests

Grasshoppers, cutworms, bertha armyworm, flea beetles, and diamond-back moths are all potential canaryseed insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Desiccation

Desiccation may be used to chemically accelerate plant drying. It does not speed crop maturity but will reduce the time from maturity to harvest. The Guide to Chemical Weed Control contains specific recommendations.

Harvesting

Swathing may begin when 25 per cent of the seeds have reached a mature color. At this stage, most of the remaining seeds may be greenish-red, and some still completely green.

Storage

Safe storage of canola (rapeseed) requires considerable care and attention. Spoilage can occur very quickly, so frequent checking of the canola is advised. High temperatures and moisture contents are the most important factors contributing to spoilage, although broken seeds and exposure to damp weather before harvesting will also increase the likelihood of spoilage.

Placing canola in small wooden bins provides no guarantee of safe storage. If the storage bin is not equipped with an aeration system, the moisture content should be 8.5% or lower. If the canola temperature is above 25°C when placed into storage, the moisture content should be below 8%. In storages equipped with aeration systems, canola can be stored safely at 9% moisture, if the temperature is reduced as soon as outside air conditions permit. Winter storage temperatures should be +5°C or lower.

FABABEANS

Seeding

Dates April 25 to May 15. Seeding should start once soil conditions permit. Late planting results in delayed maturity and extreme frost hazard.

Rates 135 or 200 kg/ha (120 to 180 lb/acre). Large seeded varieties require the higher rates.

Depth 6 to 10 cm (2.5 to 4 in). Fababeans are slow to emerge and must be in contact with moisture until well established.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 in).

Nitrogen is not recommended. Phosphorous is recommended at 30 to 45 kg/ha (27 to 40 lb/acre) P_2O_5 as a sideband application. If applied with the seed the maximum rate of P_2O_5 recommended is 20 kg/ha (18 lb/acre). Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) potash (K_2O). Place potassium away from the seed.

Sulphate sulphur (S) at a rate of 20 kg/ha (18 lb/acre) is recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information on the application of different forms of sulphur fertilizer see page 19.

Potential Insect Pests

Aphids are the prime potential insect pests for fababeans. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Fababeans are susceptible to a number of diseases which attack other broad-leaved crops. Use of seed known to be free of Ascochyta is recommended to avoid losses from seed borne Ascochyta blight. Follow a crop rotation of at least four years between successive crops of fababeans to control Ascochyta and other soil borne diseases. Because of Sclerotinia disease, field beans, field peas, lentils, mustard, safflower, canola, rapeseed, soybeans and sunflowers should be avoided in the rotation. For further information on Sclerotinia Disease, see the instruction — Disease Control and Table 1.

Harvesting

Begin swathing when 10 to 20 per cent of the pods have darkened. Reduced cylinder speed and maximum concave clearance will minimize seed damage. Fababeans are considered dry at 16 per cent moisture content.

FIELD BEANS

Seeding

Field beans are easily damaged by spring and fall frosts, so early and late seeding should be avoided. Innoculate seed with the recommended nodule forming bacterium.

Dates Navy Beans — May 24 to June 1
Black Beans — May 20 to May 27
Pinto Beans — May 20 to May 27

Rates Navy Beans — 45 kg/ha (40 lb/acre)
Black Beans — 45-55 kg/ha (40-49 lb/acre)
Pinto Beans — 60-70 kg/ha (54-62 lb/acre)

Depth 4 to 6 cm (1.5 to 2.5 inches)

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 in).

Nitrogen is not recommended for any bean crops. Phosphorous is not recommended for black beans. For other field beans apply 30 to 45 kg/ha (27 to 40 lb/acre) P_2O_5 as a sideband application. If applied with the seed the maximum rate of P_2O_5 recommended is 20 kg/ha (18 lb/acre). Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) potash (K_2O). Place potassium away from the seed.

Sulphate sulphur (S) at a rate of 20 kg/ha (18 lbs/acre) is recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information on the application of different forms of sulphur fertilizer see page 19.

Desiccation

Desiccation may be used to chemically accelerate plant drying. It does not speed crop maturity but will reduce the time from maturity to harvest. Check Manitoba Agriculture's annual Guide to Chemical Weed Control for specific recommendations.

Disease Control

Bacterial Blight Use pedigreed seed or seed known to be free from bacterial blight. Apply tribasic copper sulphate (Tri cop) or cupric hydroxide (Kocide 101) at 1.1 to 3.3 kg/ha (1 to 3 lb/acre) at first sign of disease. Do not apply within one day of harvest. Chemical control may not be practical except for small seed plots or other special situations. Avoid working fields when leaves are wet.

Bean Rust Heavy infection of rust reduces yield particularly of pinto beans. After harvest turn under all bean refuse as completely as possible.

Sclerotinia Disease (white mold) Avoid fababeans, field peas, lentils, mustard, canola, rapeseed, safflower, soybeans and sunflowers in the rotation. Any of the following chemicals may be applied as a protectant treatment: benomyl (Benlate 50WP) at 2.2 kg/ha (2 lb/acre); chlorothalonil (Bravo 75WP) 3.3 kg/ha (3 lb/acre) or (Bravo 6F) at 4.25 L/ha (3 pints/acre); thiophanate methyl (Easout 70WP) at 2.2 kg/ha (2 lb/acre); iprodione (Rovral 50WP) at 1 kg/ha (.9 lb/acre). These fungicides should be applied at specific flowering times and for details of the precise timing of application see the label of the particular chemical. Thorough coverage of blossoms is essential. Do not apply any of these chemicals within 14 days of harvest. Avoid dense foliage favorable for disease development by restricting nitrogen. Follow a crop rotation of four years to control Sclerotinia and other soil-borne diseases.

For further information, see the introduction — Disease Control and Table 1.

Special Notes

Field beans are sensitive to certain herbicide residues such as atrazine. Extreme care must be used in applying herbicides to any crop that is to precede a bean crop. A row spacing of 60 to 70 cm (24 to 28 inches) is advisable, particularly if specialized bean equipment is being used.

FIELD PEAS

Seeding

Inoculate seed with a recommended nodule forming bacterium.

Dates May 1 to May 25.

Rates Large-seeded — 170-200 kg/ha (2½ to 3 bu/acre).
Small-seeded — 130 kg/ha (2 bu/acre).

Depth 5 to 8 cm (2 to 3 in).

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 in) and 15 to 60 cm (6 to 24 in).

Nitrogen is not recommended. Phosphorous is recommended at 30 to 45 kg/ha (27 to 40 lb/acre) P_2O_5 as a sideband application. If applied with the seed the maximum rate of P_2O_5 recommended is 20 kg/ha (18 lb/acre). Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) potash (K_2O). Place potassium away from the seed. Twenty kg/ha (18 lb/acre) sulphate sulphur (S) is recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information on the application of different forms of sulphur fertilizer see page 19.

Potential Insect Pests

Aphids are the only potential insect pests for field peas. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Field peas are susceptible to a number of diseases which attack other broad-leaved crops. Use of seed tested for disease is strongly recommended to avoid losses from seed borne Ascochyta. Follow a crop rotation of at least four years between successive crops of peas to control Ascochyta and other soil borne diseases. Plant peas as far as possible from pea fields of the previous year. Bury refuse and stubble after harvest and control volunteer seedlings soon after emergence. Because of Sclerotinia disease, avoid field beans, lentils, mustard, canola, rapeseed, safflower, soybeans and sunflowers in the rotation. For further information see the introduction — Disease Control and Table 1.

Desiccation

To chemically accelerate plant drying, desiccation may be used. It does not speed crop maturity, but will reduce the time from maturity to harvest. Refer to Manitoba Agriculture annual Guide to Chemical Weed Control for specific recommendations.

Insect Control

Aphids If white patches appear on pea foliage, severe damage can be expected. For recommended insecticides see Table 2.

Harvesting

Harvest peas only when they are mature and hard in the pod. In yellow-seeded cultivars harvesting can commence at 16 per cent seed moisture. To maintain good color quality in green-seeded cultivars they can be harvested at 18 per cent seed moisture but should be dried down to 16 per cent moisture for safe storage. Delay in harvesting after maturity will reduce quality of peas. Green-seeded cultivars are especially susceptible to weathering and bleach easily if left in the field. All immature peas and weed seeds should be removed before storage.

FLAX

Seeding

Dates Early maturing varieties — May 10 to June 10
Late maturing varieties — May 10 to May 30
These seeding dates represent a suggested maximum range. Location and climatic conditions will determine optimum seeding date.

Rates 30 to 45 kg/ha (27 to 40 lb/acre). Actual rate used will depend upon seedbed preparation, size of seed, percentage germination, moisture reserves and weed competition.

Depth 2.5 to 4 cm (1 to 1.5 in). Flax should not be placed deeper than necessary to assure contact with moisture. Deeper seeding may result in decreased emergence and weaker plants. Shallow tillage before seeding will ensure a firm seedbed which promotes good stands and good plant vigor. If deep tillage is necessary, packing before or after seeding may be required.

Fertilizer

For specific recommendations have your soil tested. Take samples at a depth of 0 to 15 cm (0 to 6 in) and 15 to 60 cm (6 to 24 in).

All fertilizer material should be placed away from the seed to avoid seed injury. When using anhydrous ammonia and aqua ammonia apply no less than five days before seeding.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)(1)		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Flax to be grown on	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	0	0	(3)	(3)	(4)	(4)	(5)	(5)
Grass and grass-legume breaking (2)	0-45	0-40	(3)	(3)	(4)	(4)	(5)	(5)
Stubble	45-70	40-62	(3)	(3)	(4)	(4)	(5)	(5)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) 30 to 45 kg/ha (27 to 40 lb/acre) of P_2O_5 is recommended if it can be applied 2.5 cm (1 inch) below the seed or be sidebanded 2.5 cm (1 inch) beside and 2.5 cm (1 inch) below the seed.

(4) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) of potash (K_2O).

(5) Low sulphur levels can occur in any Manitoba soil. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information regarding the application of the different forms of sulphur fertilizer refer to page 19.

Potential Insect Pests

Grasshoppers, aphids, cutworms, and bertha armyworms are potential insect pests for flax. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

For seed rot and seedling blight control, flax seed should be treated (refer to Table 2). Follow a four year crop rotation and avoid legumes, potatoes and sugar beets because of Rhizoctonia (see Table 1).

The recommended varieties are resistant to rust. Planting non-recommended rust susceptible cultivars, increases the risk of yield losses. To reduce the threat of pasmo and rust, use clean seed, control volunteer flax and plant early. Do not plant on or near flax stubble.

Harvesting

Flax may be swathed after 75 per cent of the bolls have turned brown, and later threshed with a combine when dry. Straight combining is possible if both plant and seeds are sufficiently dry. Desiccation may be used to accelerate plant drying. It does not speed crop maturity but will reduce the time from maturity to harvest. For specific recommendations, consult Manitoba Agriculture's annual Guide to Chemical Control. A maximum of 10.5 per cent moisture is considered safe for storage of seed.

LENTILS

Seeding

Innoculate seed with a specific lentil inoculum.

Dates May 1 - 15

Rates 35-80 kg/ha (30-72 lb/acre) Large seeded varieties require the higher rates.

Depth 2.5-4 cm (1-1.5 in)

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Nitrogen is not recommended. Phosphorous is recommended at 35 to 45 kg/ha (27 to 40 lb/acre) P_2O_5 as a sideband application. If applied with the seed, the maximum rate of P_2O_5 recommended is 20 kg/ha (18 lb/acre). Sands, sandy loam and organic soils are frequently low in abailable potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) potash (K_2O). Place potassium away from the seed. Twenty kg/ha (18 lb/acre) sulphate sulphur (S) is recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information regarding the application of the different forms of sulphur fertilizer see page 19.

Disease Control

Follow a crop rotation of four years for control of soil borne diseases. Avoid fababeans, field beans, field peas, mustard, canola, rapeseed, safflower, soybeans and sunflowers in the rotation because of Sclerotinia disease (white mold).

For further information, refer to the introduction — Disease Control and Table 1. To prevent Ascochyta blight, plant only clean, non-discolored, sound seed. If there is doubt that the seed is free from the pathogen, obtain an agar plate test through the Plant Pathology Laboratory, Manitoba Agriculture or the Plant Health and Plant Products Division, Agriculture Canada. Turn under crop refuse soon after harvest, control volunteer seedlings and avoid planting lentils close to the previous year's field.

Harvesting

Lentils should be swathed when plants begin to turn yellow and the lower pods are brown to brown-yellow in color. To minimize shattering, swathing should not be carried out during hot dry periods of the day. Lentils are considered dry at 14 per cent moisture content. Combining at or below this moisture level may result in high shattering losses and damaged seed, therefore, it may be advisable to combine at a higher moisture content of 18 to 20 per cent and then dry artificially. Lentils can be straight combined if uniformly mature.

MUSTARD

Seeding

Dates May 5 to May 30

Rate Yellow — 8 to 11 kg/ha (7 to 10 lb/acre)
Brown and Oriental — 4.5 to 7 kg/ha (4 to 6 lb/acre)

Depth 2.5 to 5 cm (1 to 2 inches)

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Nitrogen in excess of 7 kg/ha (6 lb/acre) and phosphorous in excess of 20 kg/ha (18 lb/acre) and all potash and sulphur should be placed away from the seed to avoid seed injury. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under soil conditions.

Mustard to be grown on	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)(1)		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	0-35	0-31	(3)	(3)	(4)	(4)	(5)	(5)
Grass and grass-legume breaking (2)	35-80	31-71	(3)	(3)	(4)	(4)	(5)	(5)
Stubble	80-100	71-89	(3)	(3)	(4)	(4)	(5)	(5)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) 30 to 45 kg/ha (27 to 40 lb/acre) of P_2O_5 as a sideband application about 2.5 cm (1 inch) to the side and 2.5 cm (1 inch) below the seed is recommended. No more than 20 kg/ha (18 lb/acre) should be placed with the seed.

(4) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) of potash (K_2O).

(5) Twenty kg/ha (18 lb/acre) of sulphate sulphur (S) are recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information regarding the application of the different forms of sulphur fertilizer refer to page 19.

Potential Insect Pests

Grasshoppers, cutworms, bertha armyworms, flea beetles, and diamondback moths are all potential insect pests for mustard. See Table 3 on page 15 for cultural control and threshold level information.

Disease Control

Treat seed to control seed rot and seedling blights.

Because of Sclerotinia disease (stem blight), fababeans, field beans, field peas, lentils, canola, safflower, rapeseed, soybeans and sunflowers should be avoided in the rotation. For further information, see the introduction — Disease Control and Table 1.

Insect Control

Flea beetles can be a problem on mustard. Seed treatments with Furadan or lindane are strongly recommended. For further control recommendations consult Table 4, and the Manitoba Agriculture publication, Insect Control on Field Crops.

Desiccation

Desiccation may be used to chemically accelerate plant drying. It does not speed crop maturity but will reduce the time from maturity to harvest. Refer to Manitoba Agriculture's Guide to Chemical Weed Control for specific recommendations.

Harvesting

Yellow mustard is resistant to shattering but the pods tend to break off under windy conditions. Harvest when pods are fully mature.

Brown and Oriental mustard are less resistant to shattering and are usually swathed. Since green seeds are a degrading factor, leave the crop standing as long as possible.

Swathing should commence when the ripest pods show signs of shattering. At this stage 75 per cent of the seeds may have reached their mature colour (yellow or brown). In order to minimize shattering, swath under dewy conditions.

Storage

Same as for canola-rapeseed. See page 40.

POTATOES

Seed Quality and Handling

Use foundation or certified seed. Non certified seed may contain latent viruses, bacterial ring rot and blackleg, which reduce yield. Tubers up to 80 g (3 ounces) should be planted whole. Cut larger tubers into blocky seed pieces 40 to 55 g (1.5 to 2 ounces) in size. Chips and slivers weighing less than 28 g (1 ounce) should be discarded. To reduce the risk of seed piece decay and reduced stands use these fungicidal treatments: thiophanate-methyl (Easout), metiram (Polyram), captan or mancozeb.

For rapid emergence, particularly with late maturing varieties plant seed in warm moist soil.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

All fertilizer should be added as a sideband application 5 cm (2 inches) beside and below the seed at time of seeding for the most efficient use of the fertilizer. No more than 90 kg/ha (80 lb/acre) nitrogen in urea form should be applied as a sideband application at time of seeding. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)[1]		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Potatoes to be grown on	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	35-30	31-45	50-60	45-54	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	50-74	45-62	50-60	45-54	(3)	(3)	(4)	(4)
Stubble	70-100	62-89	50-60	45-54	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 50 to 90 kg/ha (45 to 80 lb/acre) of potash (K_2O). If the potassium fertilizer is broadcast applied the rate should be doubled.

(4) Twenty kg/ha (18 lb/acre) of sulphate sulphur (S) are recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information regarding the application of the different forms of sulphur fertilizer refer to page 19.

Excess nutrient levels may occur when high rates of fertilizer are used and can result in decreased quality and storge characteristics. Soil testing to a depth of 60 cm (24 inches) is strongly recommended to monitor nutrient levels and producers should avoid applying fertilizers at rates in excess of those recommended by a soil test.

Disease Control

Follow a crop rotation of four years to control soil-borne diseases. Avoid alfalfa, flax, canola, rapeseed, sugar beets, sunflowers and sweet clover in the rotation (see Table 1). Control volunteer plants which may be sources of virus diseases and late blight.

Bacterial Ring Rot and Blackleg Equipment and storage areas should be sanitized regularly to reduce the spread of bacterial ring rot and blackleg. Use steam or a high pressure washer to clean the surface of equipment and follow with a suitable disinfectant such as Formaldehyde (dil. 1:8), Phenol (Kem-Germ), quarternary ammonium (Hy-X, Potato Gard, or Teramine), sodium hypochlorite (household bleach, dil 1:2). Dispose of cull tubers to eliminate possible sources of inoculum of bacterial diseases.

Blight Early blight and late blight can be controlled by fungicidal sprays. A regular spray program using maneb, mancozeb, metiram (Polyram), captafol (Difolatan), chlorothalonil (Bravo), anilazine (Dyrene), zineb or fixed copper, should be practised according to directions on the label.

Storage Diseases For control of silverscurf and fusarium dry rot treat tubers with the fungicide thiabendazole (Mertect) as they are being put into storage. Export potatoes should not be treated at the Canadian rate.

Additional information is available in the Manitoba Agriculture annual publication Vegetable Crop Production Guide.

Potential Insect Pests

Colorado potato beetles, and potato leafhoppers are potential insect pests. See Table 3 on page 15 for cultural control and threshold level information.

Sprout Inhibition

Potatoes can be chemically sprout inhibited by field treatment using maleic hydrazide (Royal MH 60SG). Contract application of C.I.P.C. (Sprout Nip) is necessary to control sprout growth on potatoes in storage because of warm storage requirements, short dormancy period, or long term storage.

Vine Killing

Use of one of several desiccants will kill top growth and assist in stopping growth of tubers and induce maturity for harvest. Recommendations are included in Manitoba Agriculture's Guide to Chemical Weed Control.

Storage

Potatoes require specialized storage to prevent frost injury and temperature fluctuation, and provide for air circulation and a high relative humidity. Acceptable table stock quality can be retained until late spring by maintaining a temperature of 4°C with a relative humidity of 90 per cent. Potatoes produced for processing require different storage temperatures. For specific recommendations, consult your processing company representative.

Mechanical Damage

The greatest single loss of tubers of marketable size and type stems from mechanical damage. Growers must exercise great care throughout the production, harvest, storage, and delivery periods to handle tubers carefully and reduce the loss resulting from mechanical injury. Careful management and attention will pay off.

NOTE: Additional information on potato practises and recommendations is available in Manitoba Agriculture's annual Vegetable Crop Production Guide. Growers producing potatoes for processing firms under contract should note and follow the company's requirements in using chemicals for crop production.

SAFFLOWER

The commercial production of safflower was reintroduced in Manitoba in recent years. This thistle-like plant grows 40 to 75 cm (16 to 30 inches) in height; is tolerant of high temperatures and relatively resistant to drought. It is adapted to well-drained, fertile soils. Safflower must be planted early since the growing season is approximately 107 to 156 days. The seedlings are frost hardy.

In 1985, the variety Saffire was developed by Lethbridge Research Station, Agriculture Canada. This variety is moderately susceptible to Alternaria blight and resistant to Sclerotinia head rot. It is an early maturing variety (99 to 141 days). Seed is distributed by SeCan Association. Seed of Saffire will be in short supply.

Safflower will not compete with weeds; therefore, this crop must be grown on clean land. To date no chemicals have been registered for use with this crop. Safflower must not follow safflower in rotation due to its susceptibilty to Alternaria blight. Because of Sclerotinia disease, fababeans, field beans, field peas, lentils, mustard, canola, rapeseed, soybeans and sunflowers should be avoided in rotation. To avoid disease problems, safflower should be grown in the dry areas of southwestern Manitoba. Because research in this crop is limited and also because it is prone to diseases, it should be considered a risk crop and grown only under contract. Additional information can be obtained from a contracting agency.

SOYBEANS

Seeding

Date May 15 to May 25

Rate 130 kg/ha (116 lb/acre)

Depth Clay — Clayloam 2 to 3 cm (.75 to 1.2 in)
Loam — Sandyloam 2 to 4 cm (.75 to 1.5 in)

Soybeans are sensitive to certain herbicide residues such as atrazine. Take extreme care in applying herbicides to any crop that is to precede

a soybean crop. A row spacing of 50 cm (20 inches) is recommended. Narrow rows are advisable when using a grain drill. Seeding with a grain drill appears to be the most practical method. Care must be taken in calibration.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Nitrogen is not recommended. Phosphorous is recommended at 30 to 45 kg/ha (27 to 40 lb/acre) P_2O_5 as a sideband application or as an application 2.5 cm (1 inch) directly below the seed. If applied with the seed the maximum rate of P_2O_5 recommended is 20 kg/ha (18 lb/acre). Sands, sandy loam, and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) potash (K_2O). Potassium should be placed away from the seed.

Sulphate sulphur (S) at a rate of 20 kg/ha (18 lbs/acre) is recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information on the application of different forms of sulphur fertilizer, see page 19.

Disease and Insect Control

Follow a crop rotation of four years to control soil-borne diseases (see Table 1). Avoid fababeans, field beans, field peas, lentils, mustard, canola, rapeseed and sunflowers in the rotation because of Sclerotinia disease. For control of seedling rot, seedling blights, and seed maggots, apply a seed treatment as recommended in Table 2. For further information see the introduction — Disease Control and Table 1.

Harvesting

Harvest soybeans when pods are dry and the soybeans are hard. Swathing and combining or direct combining may be used. A floating cutterbar attachment on the swather or combine is useful. To prevent shattering, swath the soybeans in the morning when pods are moist and tough. Careful adjustment of the cylinder speed and concave clearance is critical to minimize cracking and splitting of soybeans. Soybeans are considered to be dry at 14 per cent moisture content.

SUGAR BEETS

This crop is grown under contract with Manitoba Sugar Company and seed is provided under the contract.

Sugar beets require relatively light to medium textured soils that are well drained. This allows earlier planting and easier establishment of good stands in spring and easier harvesting in fall.

Seeding

Dates As early as possible, about May 1.

Rates Space seeds 7.5 cm (3 inches) apart if beet thinning is planned (2.7 kg/ha) (2.4 lb/acre)
Space seeds 15 cm (6 inches) apart if planting to a final stand without thinning (1.3 kg/ha) (1.2 lb/acre)

Depth 2.5 to 3.5 cm (1 to 1.4 inches) depending on seedbed conditions.

Row Spacing 56 cm (22 inches) between rows.

Fertilizer

For specific recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Drill no more than 20 kg/ha (18 lb/acre) phosphate with the seed. Work the remaining phosphate in before planting. Any nitrogen above 5 kg/ha (4 lb/acre) and all potash and sulphur should be applied prior to planting. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)[1]		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Beets to be grown on	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**
Fallow or legume breaking (2)	0-20	0-18	65	58	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	20-65	18-58	65	58	(3)	(3)	(4)	(4)
Stubble	65-100	58-89	65	58	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 50 to 90 kg/ha (45 to 80 lb/acre) of potash (K_2O).

(4) Twenty kg/ha (18 lb/acre) of **sulphate sulphur** (S) are recommended on well-drained sandy soils. For information on the application of different forms of sulphur fertilizer, see page 19.

Excess nutrient levels may occur when high rates of fertilizer are used and can result in decreased quality characteristics. Soil testing to a depth of 60 cm (24 inches) is strongly recommended to monitor nutrient levels and producers should avoid applying fertilizers at rates in excess of those recommended by a soil test.

Disease Control

Follow a crop rotation of at least four years to control soil-borne diseases (see Table 1). Avoid canola, rapeseed and mustard in the crop rotation

because of sugar beet cyst nematodes. All seed is treated against damping-off diseases prior to sale.

Potential Insect Pests

Sugar beet root maggot is the only potential sugar beet insect pest. See Table 3 on page 15 for cultural control and threshold level information.

NOTE: Avoid seeding sugar beets on fields previously treated with Glean.

SUNFLOWERS

Seeding

Dates All varieties should be seeded early if possible. Seedlings are relatively frost resistant up to the four leaf stage. If late seeding is necessary, early maturing varieties should be used.
Zone 3, south of Township 15: May 1 to June 5.
All other regions: May 1 to May 15.

Rates A final population of 40,000 to 49,000 plants/ha (16,000 to 20,000 plants/acre) is recommended for oil type cultivars and hybrids. Non-oilseed types, a population of not more than 45,000 plants/ha (18,000 plants/acre) is recommended to ensure large seeds. Consider seed size in determining the quantity of seed required for seeding. Allowance must be made for low germination, reduced emergence, and the number of harrowings anticipated. Plant population depends on distance between rows and on spacing between plants within the row. See following table.

	Row spacing — cm (inches)				
Plants/ha (acre)	**40(16)**	**46(18)**	**56(22)**	**76(30)**	**91(36)**
	Average seed spacing within row — cm (inches)				
40,000 (16,000)	58(23)	50(20)	41(16)	30(12)	25(10)
45,000 (18,000)	51(20)	44(17)	36(14)	26(10)	22(9)
49,000 (20,000)	46(18)	40(16)	33(13)	24(9)	29(8)

Stands may be reduced by harrowing. The frequency and severity of harrowing will determine the per cent stand reduction, and seeding rate is increased accordingly.

Sunflower seed is sold in different sizes. The approximate number of seeds for the different sizes are:

	Seeds/kg	**(Seeds/lb)**
Seed size No. 2	11,000 - 13,200	(5,000 - 6,000)
Seed size No. 3	13,200 - 15,400	(6,000 - 7,000)
Seed size No. 4	15,400 - 19,800	(7,000 - 9,000)
Seed size No. 5	19,800 - 24,200	(9,000 - 11,000)

Depth Seed should be placed into moisture even if this means seeding to 8 to 10 cm (3 to 4 inches)

Fertilizer

For specific target yield recommendations have your soil tested. Take samples at depths of 0 to 15 cm (0 to 6 inches) and 15 to 60 cm (6 to 24 inches).

Germinating sunflower seeds are sensitive to moderate amounts of fertilizer placed with the seed.

Row Equipment When sunflowers are seeded with row equipment, all phosphorous and potash should be side-banded 5 cm (2 inches) beside and below the seed at seeding time. Some or all of the nitrogen may also be side-banded. The total amount of fertilizer material side-banded should not exceed 340 kg/ha (303 lb/acre).

Discer Seeder When sunflowers are solid-seeded with a discer seeder in 30 to 60 cm (12 to 24 inches) row spacing, up to 25 kg/ha (22 lb/acre) P_2O_5 can be applied provided all fertilizer runs are left operating. If all phosphorous must be placed with the seed, the amount of phosphorous should not exceed 15 kg/ha (13 lbs/acre) for 30 cm (12 inches) row spacing, 10 kg/ha (9 lb/acre) for 45 cm (18 inches) row spacing and 5 kg/ha (4 lb/acre) for 60 cm (24 inches) row spacings.

Nitrogen requirements not side-banded should be placed away from the seed as a band or broadcast application. When the crop is seeded less than five days after the application of anhydrous ammonia and aqua ammonia, damage may occur particularly on sandy soils or under dry soil conditions.

	RATE OF NUTRIENT TO ADD							
Sunflowers to be grown on	**Nitrogen (N)[1]**		**Phosphate (P_2O_5)**		**Potash (K_2O)**		**Sulphur (S)**	
	kg/ha	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**
Fallow or legume breaking (2)	0-30	0-27	30-45	27-40	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	30-60	27-54	30-45	27-40	(3)	(3)	(4)	(4)
Stubble	60-100	54-89	30-45	27-40	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 15 to 35 kg/ha (13 to 31 lb/acre) of potash (K_2O). If the potassium fertilizer is broadcast applied the rate should at least be doubled.

(4) Twenty kg/ha (18 lb/acre) of **sulphate sulphur** (S) are recommended on well-drained sandy soils. For information on the application of different forms of sulphur fertilizer, see page 19.

Weed Control

Cultural Methods Cross harrowing (after planting, before and after emergence of the sunflowers) with early inter-row cultivation will usually give satisfactory control of most weeds.

Disease Control

Sclerotinia wilt or basal stem rot, Verticillium wilt, rust and downy mildew are serious sunflower diseases.

No cultivar is resistant to Sclerotinia disease. Sclerotinia wilt spreads by root contact, and the denser the plants, the greater its incidence and severity. Do not exceed the recommended seeding rates, and space plants uniformly. Plant to plant spread of the disease is reduced at spacings of 30 cm (12 inches) and larger, and is prevented at 40 cm (16 inches). Use well cleaned seed free of sclerotia (black, hard fungal bodies).

Follow a crop rotation of at least five years to control soilborne diseases in general. Avoid fababeans, field beans, field peas, lentils, mustard, canola, rapeseed, safflower and soybeans in the rotation to control Sclerotinia disease. The organisms that cause Verticillium wilt and downy mildew survive in soil for many years, and are best controlled by planting resistant varieties. For further control of Verticillium wilt, avoid alfalfa, potato and sweet clover in the rotation. To reduce the incidence of rust use resistant varieties, control volunteer plants and do not sow sunflowers adjacent to sunflower stubble. To reduce the incidence of downy mildew, avoid planting in poorly drained fields. For further information see the introduction — Disease Control and Table 1.

Potential Insect Pests

Cutworms, and sunflower beetles are potential insect pests for sunflowers. See Table 3 on page 15 for cultural control and threshold level information.

Harvesting

The period between maturity and harvest should be kept as short as possible to keep to a minimum losses due to bird damage and/or head rot diseases. Rather than waiting for a frost, a desiccant may be used to accelerate drying of sunflower plants. For details, see Manitoba Agriculture's Guide to Chemical Weed Control.

Sunflower seed can be stored with moisture level of 10 per cent or less. A moisture level of 8.5 per cent or less is more desirable, but even at this level spoilage can occur if the temperature is not reduced at the time the seed is put into storage.

WILD RICE

Wild rice may be produced in paddies containing 15 to 45 cm (6 to 18 inches) or more of water. Seeding at a rate of 35 kg/ha (30 lb/acre) can be done by broadcasting into water or onto wet ground which is then flooded either in the fall or spring. Fall seeding is an advantage since the problems of seed storage are avoided. Paddies may be harvested with float mounted equipment or drained and harvested with a combine equipped with extended tracks and a rice header.

Shallow peat or mineral soils in the natural wild rice area are used for wild rice production. Soil conditions that permit maintenance of adequate water levels in the paddies are essential.

The quantity of water available should be carefully assessed. A licence must be obtained before paddy construction.

Initial dike construction should facilitate patrol, maintenance and sanitation. Control of plant growth on dikes assists in weed and disease control in the paddies.

Weed Control

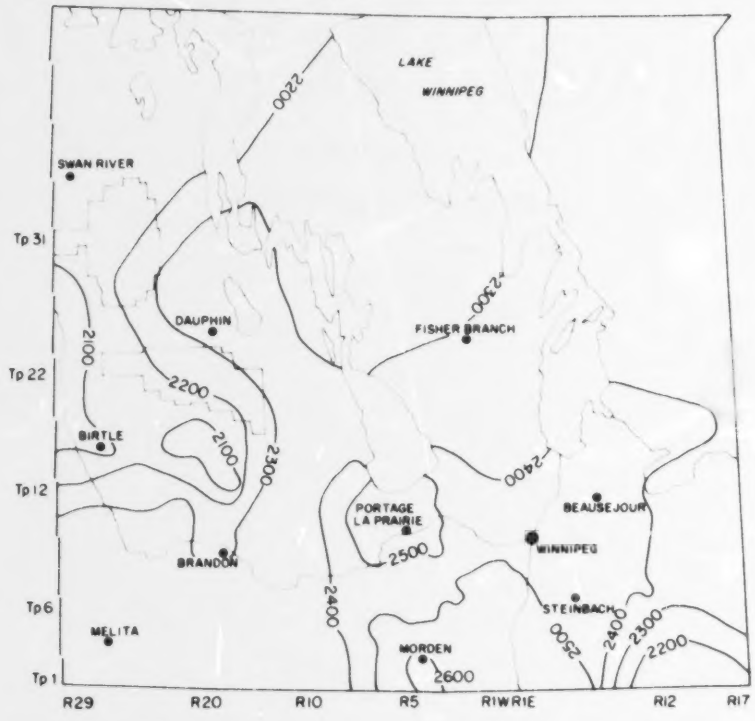
Major problem weeds include cattails, burr weed and duck weed. Some control can be achieved through water level management and fall tillage.

Disease, Insect and Variety Notes

Leaf spot disease may cause loss. Wild rice worm consumes the grain from pollination onwards. Native wild rice shatters readily and ripens unevenly although some recently developed varieties provide a degree of shatter resistance with acceptable maturity characteristics. For further information see the Manitoba Agriculture factsheet Wild Rice Production in Manitoba and Guide to Wild Rice Production booklet.

CORN

Figure 1 — Corn Heat Unit Map for Manitoba



Corn Heat Units

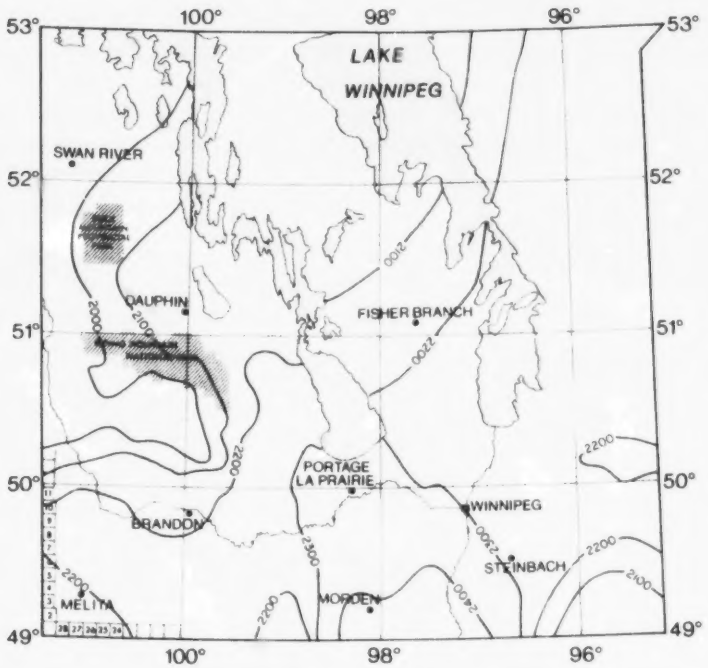
The corn production potential of an area is determined primarily by the corn heat unit accumulation. These units are calculated each day from May 15 to the date of the first frost at −2°C in the fall. Daily accumulations are summed to give a seasonal total. The map above is an average seasonal accumulation.

How to Use The Map

If you plan to grow corn for grain, find your farm location on the map and observe the heat units available. When planting in early May, choose hybrids with a heat unit rating no greater than that available on your farm. If, for any reason, planting is delayed until after mid-May, deduct 100 heat units from the rating for your farm for each week of delay and select hybrids accordingly.

For silage corn the heat unit requirement is 200 lower than for grain corn since silage is harvested before full maturity. Hybrids requiring 200 heat units more than the rating for an area can be used in silage production, e.g. a 2,400 heat unit hybrid may be used in a 2,200 heat unit area.

Figure 2 — Minimum Accumulation of Corn Heat Units at a 25% Risk

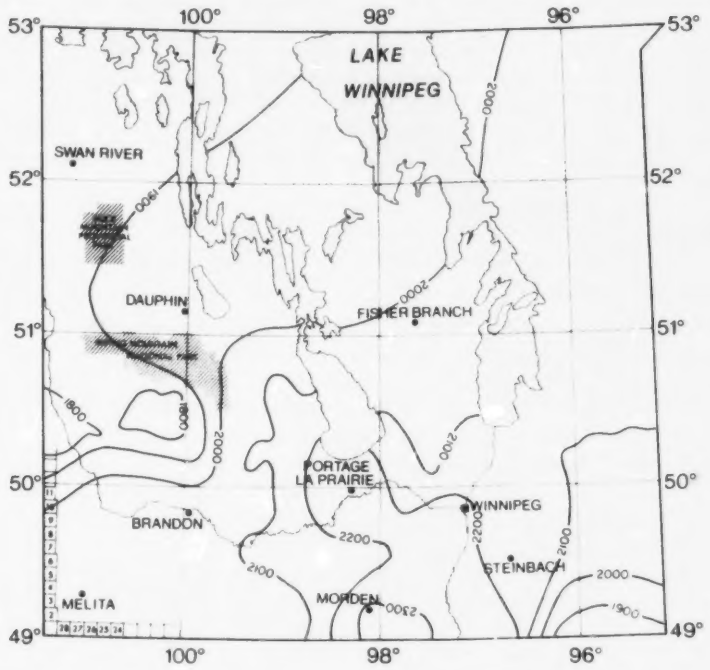


Reducing The Risk In Corn Production

The corn heat unit map shown in Figure 2 is the average corn heat unit accumulation, i.e. in approximately one-half the years the actual corn heat unit accumulation will be more than that shown on the map, while in the other half of the years, it will be less. Thus the map is a 50% risk map. If you chose a hybrid with the same heat unit rating as your farm, 50% of the years it would not reach maturity.

Let us assume you want to reduce your risk to 25%, i.e. you are prepared to have immature corn one year in four. In this case instead of using the average corn heat unit map (Figure 2), you would use the 25% risk map (Figure 3) in choosing your hybrid. Similarly, if you wish to reduce your risk to 10%, you would use the 10% risk map (Figure 4) in choosing your hybrid.

Figure 3 — Minimum Accumulation of Corn Heat Units at a 10% Risk



Management Practices

Successful corn production requires intensive management. New growers should consult their nearest agronomist for detailed advice on the proper techniques and materials for planting, fertilizing, spraying, harvesting, storage, etc. Obtain a copy of the Manitoba Agriculture publication Field Corn in Manitoba. Corn crops properly managed in all aspects of production, hold good potential for high yields. However, improper management of any one aspect of production may lead to poor results — unlike cereals in which average management usually leads to average yield. Basic recommended practices are:

Soil Requirements Corn is best adapted to well-drained, light to medium sandy loam soils. These soils usually permit early May planting, which is essential for optimum yields of good quality grain. Corn should not be grown on soils that are either poorly drained or saline (showing a conductivity reading above one millisiemen by soil test).

Seeding

Dates May 1 to May 15. Later planting results in lower yields and quality. Planting later than May 25 for grain and June 5 for silage is not recommended.

Depth Plant into moist soil. Under normal soil moisture conditions the suggested depth is 2.5 to 5 cm (1 to 2 in). Very dry soil conditions may require deeper planting. Check planting depth frequently to ensure uniform and early emergence.

Row Spacing 75 to 100 cm (30 to 40 in) depending on planting and harvesting equipment.

Rates Hybrid corn is sold in many sizes. Growers using platetype planters must use the correct plate for each seed size to obtain the desired plant population.

Grain corn — 45,000 to 60,000 plants/ha (18,000 to 24,000 plants/acre)

Silage corn — 55,000 to 70,000 plants/ha (22,000 to 28,000 plants/acre)

The lower plant populations are recommended for areas in which moisture is a limiting factor. Similarly, plant population should be reduced if planting is delayed beyond the recommended dates. Plant population depends on seed spacing within the row and on spacing between rows. See following Table.

Seed Spacing Necessary to Give the Required Plant Population Assuming an 85% Plant Survival

Row Width cm (inches)	Plants per ha(acre) 45,000 (18,000)	Plants per ha(acre) 49,000 (20,000)	Plants per ha(acre) 55,000 (22,000)	Plants per ha(acre) 60,000 (24,000)	Plants per ha(acre) 69,000 (28,000)
	cm(in)	cm(in)	cm(in)	cm(in)	cm(in)
76(30)	25(9.9)	23(8.9)	20(8.1)	19(7.4)	16(6.3)
91(36)	21(8.2)	19(7.4)	17(6.7)	16(6.2)	14(5.3)
97(38)	20(7.8)	18(7.0)	16(6.4)	15(5.8)	13(5.0)
102(40)	19(7.4)	17(6.7)	15(6.1)	14(5.6)	12(4.8)

Fertilizer

For specific target yield recommendations have your soil tested. Samples should be taken at depths of 0 to 15 cm (0 to 6 in) and 15 to 60 cm (6 to 24 in).

Phosphate, potash and nitrogen when possible should be banded 5 cm (2 in) beside and below the seed row at time of seeding. The total amount of fertilizer material side-banded should not exceed 340 kg/ha (303 lb/acre). Nitrogen requirements not side-banded at time of seeding should be side-dressed before the corn is 15 cm (6 inches) high.

	RATE OF NUTRIENT TO ADD							
	Nitrogen (N)(1)		Phosphate (P_2O_5)		Potash (K_2O)		Sulphur (S)	
Corn to be grown on	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre	kg/ha	lb/acre
Fallow or legume breaking (2)	0-30	0-27	30-45	27-40	(3)	(3)	(4)	(4)
Grass and grass-legume breaking (2)	30-75	27-67	30-45	27-40	(3)	(3)	(4)	(4)
Stubble	75-150	67-134	30-45	27-40	(3)	(3)	(4)	(4)

(1) Rates are based on granular nitrogen applied broadcast at or near seeding time. See section Relative Efficiencies of Time and Method of Nitrogen Application, pages 16 and 17.

(2) Refers to breaking after first cut of forage.

(3) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 30 to 110 kg/ha (27 to 98 lb/acre) of potash (K_2O). If the potassium fertilizer is broadcast applied the rate should be doubled.

(4) Twenty kg/ha (18 lb/acre) of **sulphate sulphur** (S) are recommended on well-drained sandy soils. For information on the application of different forms of sulphur fertilizer see page 19.

Excess nutrient levels may occur when high rates of fertilizer are used on continuous corn. Soil testing to a depth of 60 cm (24 inches) is strongly recommended to monitor nutrient levels and avoid over-fertilization.

To determine the possible cause of poor growth due to nutrient deficiencies, see pages 20 and 21 of the publication, Field Corn in Manitoba, and contact your local agronomist.

Disease Control

Stalk rot is considered the main disease of corn. It causes diseased plants to break over before harvest, resulting in severe losses. Organisms causing the disease are present in all soils. The disease usually occurs following periods of severe stress such as drought, or prolonged cool weather. For control measures, see the Manitoba Agriculture publication Field Corn in Manitoba. Continuous cropping of corn can lead to a buildup of stalk rot and corn smut. Seed should be treated with a suitable fungicide to prevent introduction of head smut (see Table 2). Rotate with cereals, other than wheat, or special crops for several years before returning field to corn (see Table 1). The Crop Rotation Chart published by Manitoba Agriculture contains further information on crop rotations.

Potential Insect Pests

European cornborer is the major potential insect pest for corn. See Table 3 on page 15 for cultural control and threshold level information.

Pest Control

Blackbirds can cause severe losses in corn production. Placement of corn fields close to sloughs and marshes should be avoided, where possible.

Harvesting

The grade of grain corn may be significantly influenced by harvesting procedure. Grain corn should contain 25 to 30 per cent kernel moisture before harvesting commences. Harvesting near the lower end of this moisture range causes a lower proportion of cracks and fines. If frost occurs before kernel moisture has reached 40 per cent harvest the crop for silage rather than grain.

Silage corn harvesting should take place when whole plant moisture is 65 to 70 per cent. Then, the kernels are usually at the hard dough stage (well-dented or glazed).

FORAGE CROPS

Recommendations

GRASSES		Seeding Rate kg/ha (lb/acre) Forage	Seed
A. All soils except where drainage is poor.			
Bromegrass	Pasture, Hay, Seed	8(7)	3(3)
Intermediate Wheatgrass	Pasture, Hay, Seed	8(7)	4(4)
Russian Wild Ryegrass	Seed		7(6)
Slender Wheatgrass	Seed		6(5)
Tall Wheatgrass	Seed		9(8)
B. Soils with ample moisture, good drainage.			
Creeping Red Fescue	Pasture	4(4)	
Meadow Fescue	Pasture, Seed	6(5)	3(3)
Orchardgrass	Pasture, Hay	7(5)	
Timothy	Pasture, Hay, Seed	2(2)	2(2)
C. Light soils and areas deficient in moisture.			
Crested Wheatgrass	Pasture, Hay, Seed	8(7)	3(3)
Russian Wild Ryegrass	Pasture	9(8)	
D. Poorly drained areas subject to temporary flooding.			
Reed Canarygrass	Pasture, Hay, Seed	7(6)	4(4)
Timothy	Pasture, Hay, Seed	2(2)	2(2)
E. Saline (white alkali) soils.*			
Russian Wild Ryegrass	Pasture	9(8)	
Slender Wheatgrass	Hay	9(8)	
Tall Wheatgrass	Hay	11(10)	

F. Organic soils.

Grow winter-hardy grasses: bluegrass, bromegrass, creeping red fescue, intermediate wheatgrass, meadow foxtail, reed canarygrass, slender wheatgrass, and timothy.

LEGUMES		Seeding Rate kg/ha (lb/acre) Forage	Seed
A. All soils except where drainage is poor.			
Alfalfa	Pasture, Hay, Seed	7(6)	1(1)
Sweet Clover	Hay, Seed	11(10)	7(6)
B. Soils with ample moisture, good drainage.			
Birdsfoot Trefoil	Pasture, Seed	4(4)	2(2)
Red Clover	Hay, Seed	7(6)	3(3)
C. Poorly drained areas subject to temporary flooding.			
Alsike	Hay, Seed	4(4)	2(2)
Birdsfoot Trefoil	Pasture, Seed	4(4)	2(2)
D. Saline (white alkali) soils.*			
Alfalfa	Hay	7(6)	
Sweet Clover	Hay	11(10)	

MIXTURES	Seeding Rate kg/ha (lb/acre) Pasture	Hay
A. All soils except where drainage is poor.		
Bromegrass	7(6)	3(3)
and Alfalfa	3(3)	7(6)
Intermediate Wheatgrass	7(6)	3(3)
and Alfalfa	3(3)	7(6)
B. Soils with ample moisture, good drainage.		
Orchardgrass	7(6)	7(6)
and Timothy	2(2)	2(2)
Timothy	2(2)	2(2)
and Alfalfa	3(3)	7(6)
Orchardgrass	7(6)	3(3)
Timothy	2(2)	2(2)
and Alfalfa	2(2)	7(6)
Timothy	2(2)	
and Birdsfoot Trefoil	2(2)	
C. Poorly drained areas subject to temporary flooding.		
Reed Canarygrass	6(5)	
Timothy	2(2)	
and Birdsfoot Trefoil	2(2)	
Reed Canarygrass		6(5)
Timothy		2(2)
and Alsike Clover		4(4)
D. Light soils and areas deficient in moisture.		
Crested Wheatgrass	8(7)	5(5)
and Alfalfa	2(2)	5(5)
E. Saline (white alkali) soils.*		
Slender Wheatgrass		5(5)
Tall Wheatgrass		5(5)
Alfalfa		3(3)
and Sweet Clover		3(3)
F. Organic Soils.		
Bromegrass		5(5)
Timothy		2(2)
and Reed Canarygrass		5(5)

*See Agriculture Canada bulletin #1624/E — The Management of Saline Soils.

TABLE 8 — SEEDING RATE OF FORAGES

Crop	Seeds/kg (1000s)	No. of Seeds/m of Row at 1 kg/ha Row Spacing 15 cm (6 in)	20 cm (8 in)	30 cm (12 in)
Grasses				
Kentucky Bluegrass	4 800	70	95	140
Bromegrass	300	4.5	6	9
Reed Canarygrass	1 175	18	24	35
Creeping Red Fescue	1 356	20	27	41
Meadow Fescue	507	8	10	15
Meadow Foxtail	1 270	19	25	38
Orchardgrass	1 442	22	29	43
Russian Wildrye	386	6	8	12
Timothy	2 712	41	55	80
Crested Wheatgrass	386	6	8	12
Intermediate Wheatgrass	194	3	4	6
Slender Wheatgrass	350	5	7	11
Tall Wheatgrass	174	2.5	3.5	5
Legumes				
Alfalfa	450	7	9	14
Alsike Clover	1 534	23	31	46
Red Clover	606	9	12	18
Sweet Clover	573	9	11	17
Birdsfoot Trefoil	827	12	17	25

SEEDING PRACTICES

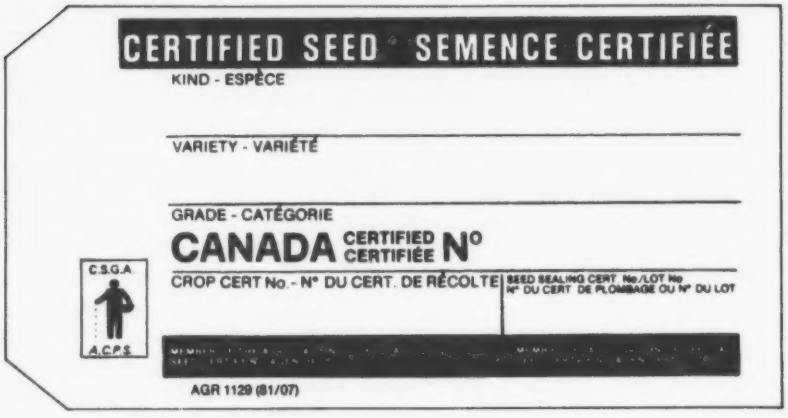
Pedigreed Seed

Whenever possible, use only pedigreed seed of the recommended varieties to be sure of a proven, high quality product that has good germination, is free from noxious weed seeds, and is adapted to your particular area. In Canada, crop seed must be pedigreed before it can be sold under a variety name. Only pedigreed seed guarantees the yield, winter hardiness, disease resistance, and other characteristics associated with a named variety.

All Pedigreed seed is identified by the type of tag shown in figure number 4. The tag has a crop certificate number and a seed certificate number. The 11-digit crop certificate number is assigned by The Canadian Seed Growers' Association. This number identifies the grower of the seed and the field that it came off.

The seed certificate number on the tag is assigned by Agriculture Canada for each lot of seed tagged by a seed inspector. There is a different number for each lot of seed.

Figure 4 — All Certified, or Pedigreed, seed is identified by the type of tag shown below.


CERTIFIED SEED · SEMENCE CERTIFIÉE
KIND - ESPÈCE
VARIETY - VARIÉTÉ
GRADE - CATÉGORIE
CANADA CERTIFIED CERTIFIÉE N°
C.S.G.A.
A.C.P.S.
CROP CERT No. - N° DU CERT. DE RÉCOLTE
SEED SEALING CERT. No/LOT No
N° DU CERT DE PLOMBAGE OU N° DU LOT
AGR 1129 (81/07)

Time of Seeding

Spring — Spring seeding of forages should be done before grain seeding gets underway. This is particularly important on light and sandy soils. In the moister areas of the province, seeding may be delayed until late May with reasonable chances of success. Where a companion crop is being used it is recommended that this field be the first field seeded.

Early Fall — If moisture supplies are adequate, grasses may be sown in August. While an early August seeding is preferred, seeding should be completed before the end of the third week in August.

Late Fall — Grasses and legumes may be seeded in the late fall. A late fall or dormant seeding, just before freeze-up, helps to ensure germination early the following spring so that the young seedlings may take full advantage of moisture from the winter snowfall. If excessive soil moisture is anticipated in the spring, it is recommended that the normal seeding rates be increased by 50%. Generally grass seeds withstand excess spring soil moisture better than legume seeds.

Field Preparation

Care must be taken to ensure that the major weed problems are eliminated from the field prior to seedbed preparation. This generally requires a suitable crop rotation with chemical and cultural weed control practices prior to seedbed preparation.

The seedbed, whether summerfallow or stubble land, must be firm. A firm seedbed makes shallow seeding possible and provides better moisture conditions near the surface. Summerfallow and recently worked stubble land should be packed immediately after cultivation and seeded as soon as possible. Undisturbed stubble land provides a firm seedbed for forage crops. Chemical weed spraying at seeding time may be required to reduce heavy weed competition which would otherwise occur on the stubble land.

Inoculation

Legume seeds require inoculation in order to ensure nitrogen fixation. This is done by coating the seed with a prepared culture of the required strain of rhizobium bacteria. Soils may contain rhizobium bacteria from a previous crop, but seed innoculation ensures nodulation. Keep inoculant in airtight containers in a refrigerator until required. This prevents drying, which reduces the viability of the bacteria. The legume seed should be innoculated just prior to the seeding operation.

Each legume or group of legumes requires a unique species of rhizobium to form nodules and fix nitrogen. The commercial inoculants available are prepared for specific legumes and groups of similar legumes:

Alfalfa Group — for alfalfa and sweet clover

Clover Group — for red clover, white clover, and alsike clover

Birdsfoot Trefoil — specific to birdsfoot trefoil.

For more information on inoculation and the proper methods of applying it to the seed, please see Manitoba Agriculture factsheet entitled Legume Inoculation (120-23) and/or Agriculture Canada publication 1299 Legume Inoculation.

Companion Crops

In general, companion crops compete with the forage seedlings for moisture, nutrients and light. They reduce the number, vigor or distribution of species within the forage stand. However, under drifting or eroding conditions and in high rainfall areas, they can be used successfully. Where used, the companion crop (flax, wheat, oats, barley, or rapeseed) should be planted at half the usual rate in a separate operation, preferably crosswise or in alternate rows to the forage crop. The crop and crop residues should be removed as early as possible.

Depth of Seeding

Shallow seeding of grasses and legumes is essential to obtain satisfactory stands. Most grasses and legumes should be seeded to a maximum of 2½ centimeters (1 inch) deep. Very small seeded crops, such as Kentucky Bluegrass, must be seeded about 1 centimeter (½ inch) deep. For even depth shallow seeding, it is advisable to use depth control attachments on the drill discs. On firm land, shallow seeding can be accomplished with a grain drill if all pressure is taken off the discs.

Seed Distribution

Stands of grasses and legumes should be uniform, with 33 to 66 plants per square meter (3 to 6 plants per square foot). Dense stands are not necessary.

Drilling the seed into the soil is better than broadcasting. The press-drill gives best results. Discers are not recommended because they generally sow too deeply. Most grain drills are not designed to seed forage crops in a continuous positive flow at low seeding rates. The drill settings to deliver these low seeding rates do not, in many instances, allow seed to continuously feed into the small opening. The lighted, awned, and pointed tip characteristics of most grasses results in uneven flow, bridging over the seed cup and in skips and misses in the rows. Grass seeder and depth control attachments may be obtained for the grain drill to permit more accurate rate and depth of seeding. Every precaution must be taken to avoid seeding the forage crop too deeply.

For most grasses and mixtures, start with a drill setting of 67 kilograms per hectare (1 bushel per acre) on the wheat scale, then try the drill on a hard surface. Count the number of seeds that drop per meter (foot of row) and then adjust to the setting required (refer to Table 8).

When seeding, the drill box should not be over one-half full or bridging may occur, causing the seed to stop flowing. Another way to prevent bridging is to mix one part cracked cereal seed with two parts of grass seed by volume. Broadcast seeding is sometimes practiced in areas of good rainfall and it may be used on rough ground or on very loose soil where the depth of seeding cannot be properly controlled. Small-seeded crops, such as alsike clover or timothy, may have to be broadcast because

of the danger of seeding too deeply with a drill. Seed may be broadcast by a grain drill, with or without a fertilizer or grass-seed attachment, or by a discer. When the discer is used the grain spouts should be removed entirely. A Cyclone broadcast seeder is useful for broadcasting seed on small areas. All broadcast seeding should be followed by harrowing. Packing after harrowing is advisable.

General Management Of Grasses And Legumes

Fertilizer

For specific recommendations, have your soil tested. Take samples at depths of 0 to 15 centimeters (0 to 6 inches) and 15 to 60 centimeters (6 to 24 inches) prior to establishment or on established stands if the possibility of a sulphur deficiency has not been eliminated. Sampling to 15 centimeters (6 inches) is useful only on established stands where sulphur levels are known to be adequate.

For new forage stands, phosphorus fertilizer can be applied most effectively by banding the material 2½ centimeters (1 inch) to the side and 2½ centimeters (1 inch) below the seed. If phosphorus cannot be banded, incorporate it and all other fertilizer materials into the soil before seeding.

Fertilizing Grass Stands

Annual broadcast applications of phosphorus, potassium and sulphur fertilizer on established grass crops may be in late fall or early spring. Do not apply fertilizer to frozen soils subject to water runoff. Response of grasses to nitrogen fertilizers depends on the type of nitrogen fertilizer, time of application, amount applied, species of grass, age of stand, number of cuts and climatic conditions. Established grass stands should be fertilized with granular fertilizers. Nitrogen solutions sprayed onto established grass stands have been found unsatisfactory and this application technique is not recommended.

	ANNUAL RATE OF NUTRIENT TO ADD					
	N		P_2O_5			
New Stands	**kg/ha**	**lb/acre**	**kg/ha**	**lb/acre**	**K_2O**	**S**
Fallow	0-20	0-18	30-45	27-45	(1)	(2)
Stubble	45-70	40-62	30-45	27-45	(1)	(2)
Established Stands	100-120	89-107	20-35	18-31	(1)	(2)

(1) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 35 to 70 kg/ha (31 to 62 lb/acre) of potash (K_2O) for established stands and 50-100 kg/ha (45 to 89 lb/acre) of potash (K_2O) for new stands.

(2) Low sulphur levels can occur in any Manitoba soil. When required apply 15 kg/ha (13 lb/acre) of sulphate sulphur. For information on the application of different forms of sulphur fertilizer, see page 20.

Source of Nitrogen

Grass For Hay — For early season grasses, (first cut) ammonium nitrate is 10 to 15 per cent more efficient than urea in increasing yield. For late season grasses urea and ammonium nitrate are equally effective in increasing yield. Urea increases the yield of the second cut (early and late season grasses) 6 - 12 per cent over that obtained with ammonium nitrate.

Grasses For Pasture — Urea is 10 - 15 per ent more effective in increasing yield than ammonium nitrate over the total grazing season.

NOTE: Crude Protein — Grasses (hay or pasture) fertilized with urea have higher crude protein levels than those fertilized with ammonium nitrate.

Time of Application

Grass for Hay or Pastures — The relative efficiency of broadcasting granular nitrogen fertilizers on established grass at different times of the year is as follows:

(1) Spring Application	April to mid May — 100
(2) Fall Application	October — 78

Split application of nitrogen during the growing season as compared to a single large application in early spring results in more efficient use of the applied nitrogen. This technique shows similar yield increases when equivalent amounts of nitrogen are added, but the protein content of the forage is maintained at higher levels. Split applications of less than 50 kg/ha (45 lb/acre) are not recommended.

Grass for Seed Production — Timing of nitrogen fertilizer application for grasseed production is very important and varies with species. The time of application of nitrogen fertilizer for various grass species is as follows:

Meadow Fescue	October or April
Timothy	October or April
Bromegrass	Right after harvest
Russian Wild Ryegrass	Right after harvest
Wheat Grasses	Right after harvest

Fertilizing Legumes

Annual applications of fertilizer on established legume crops may be in the fall or early spring. Do not apply fertilizer to frozen soils subject to water runoff.

Additional information is contained in Manitoba Agriculture factsheet 'Fertilizing Alfalfa Forage', Agdex 541.

	ANNUAL RATE OF NUTRIENT TO ADD					
	N		P_2O_5			
	kg/ha	lb/acre	kg/ha	lb/acre	K_2O	S
New Stands	0	0	60-85	54-76	(1)	(2)
Established Stands	0	0	45-60	40-54	(1)	(2)

(1) Sands, sandy loam and organic soils are frequently low in available potassium. On these soils apply 65 to 170 kg/ha (58 to 152 lb/acre) of potash (K_2O) at the time of establishment or 45-110 kg/ha (40 to 98 lb/acre) of potash (K_2O) for established stands.

(2) 30 kg/ha (27 lb/acre) of sulfate sulphur (S) are recommended on well-drained sandy soils and grey luvisol (grey wooded) soils. For information on the application of different forms of sulphur fertilizer see page 20.

Fertilizing Mixtures

If the mixed stand contains more than 25 per cent legume, fertilize as for a pure legume stand. If there is less than 25 per cent legume in the stand, use the recommendation for pure grass stand.

Disease Control

Leaf diseases are the most commonly encountered and conspicuous disease problem with the forage grasses. If the incidence of leaf disease becomes severe, rotate the field to other crops for several years.

Ergot can be a serious problem on bromegrass and wheatgrasses. Mowing the grass at heading time will prevent the formation of ergot bodies in the developing florets. This also stops spread of the disease to nearby fields of rye, triticale, wheat, or barley. After breaking up a seed field where ergot has been a problem, avoid rye, triticale, wheat, or barley for one year.

Forage legumes are susceptible to a number of leafspot diseases. They are also affected by root and crown rots which may be associated with winter injury. Foliage diseases overwinter on infected stubble and may build up to become a severe problem. Cut before leafdrop to minimize leaf loss, reducing the amount of overwintering disease. Take severely infested fields out of production. Early spring burning prior to new growth may also reduce leaf and stem diseases. Rotate with cereals or corn for at least one year before replanting to a forage legume. (See Crop Disease Table 1 page 9).

Alfalfa and sweet clover are susceptible to verticillium wilt. To help prevent its introduction, seed can be treated with the fungicide Thiram. Avoid potatoes and sunflowers in the rotation, because of common susceptibility to verticillium wilt.

For further information, refer to Manitoba Agriculture factsheet entitled Diseases and Deficiencies of Forages Agdex 120.

Weed Control

For recommended herbicides and rates of application refer to Manitoba Agriculture publication The Guide to Chemical Weed Control.

Critical Period For Alfalfa

Autumn management of alfalfa is probably the single most important aspect of management, affecting the health, vigor, persistance and production of the stand. Alfalfa stores food reserves in its roots. Such food makes the plant resistant to low winter temperatures and is used to initiate new growth in the spring and after each harvest. Cutting or grazing in the fall weakens plants to the level where large numbers may be winterkilled or later yields may be greatly reduced. This period is known as the 'critical fall harvest period', and is generally five weeks before the first killing frost. Leaf growth is needed during the critical fall period to synthesize food for storage in the roots and crowns. If early fall cutting is practiced, the food reserves in the roots are used to initiate new plant growth. As a consequence, plants may go into the winter low in essential food reserves. Having large food reserves in the roots and crowns does not assure that plants will survive the winter; but, plants low in these food reserves are most likely to be injured or killed. A cutting at about the average time of a killing frost is less hazardous than cutting before that time. Late fall cutting, however, removes the stubble which would catch and hold snow; the latter acts as an effective insulation blanket to protect the alfalfa during winter and early spring, thus providing additional insurance against winter kill. During these late fall cutting it is advisable to leave a two or three foot uncut strip every swather width to act as a snow trap.

Stands that have been winter injured need conservation management to keep them in a productive condition. Winter injured plants are usually slow to start growth in the spring and are weak in appearance, yellowish in color, and poor in numbers of shoots. Most winter injured plants of disease resistant cultivars can recover to near full production if the first cutting is delayed until late bloom stage. Severely injured stands should be plowed. Cutting at immature stage may kill winter injured plants or keep them in a weakened condition.

Green Manure

Green manuring is the practice of turning green plant material into the soil to increase the organic matter. Organic matter improves soil structure, increases water holding capacity, and increases soil microbial activity.

Legumes are the preferred crops because they will increase soil nitrogen. Sweet clover is the most common green manure crop used in Manitoba. Alfalfa or alfalfa grass can be used for the same purpose. Red or alsike clover may be sown in very moist areas. Annual or winter cereals or annual grain legumes (field pea or fababean) may also be used. Non-legumes will provide cover and return organic matter but do not increase soil nitrogen.

Legumes contain about 3% nitrogen on a dry matter basis. For example, 1 tonne (1.1 ton) of sweet clover would contain 30 kilograms (60 lbs) of nitrogen, about half of which is available to the crop the year following plow-down. For maximum effect, the whole crop would be incorporated but economics or need may dictate harvesting the top grown for forage. To provide maximum nitrogen and to minimize soil moisture use, plow-down should take place at the early bloom stage of growth.

The green manure crop may be incorporated with a single or double disc, one-way discer, or offset disc preceded or followed by a heavyduty cultivator. Normal fallow operations are used afterwards.

Generally, cereals follow the green manure crop. Although nitrogen requirements will be reduced, it is recommended that producers soil test to determine the cost benefits of additional nitrogen fertilizer. Green manure will not replace phosphorus, sulphur, or potash.

MAKING GOOD QUALITY HAY AND SILAGE

The gains in weight or milk production from feeding hay or silage are determined to a large extent by protein and fibre contents and digestibility of feed. Low quality roughage may be offset by feeding protein supplements and/or grain. Such practices generally are more costly than feeding good quality roughage. Essential factors in making high quality hay or silage are as follows:

1) ***Stage of Plant Growth*** — This is the most important single factor controlling forage quality. As crops advance from early leaf to seed stages, they gradually lose feed quality (see Figure 5). Most grasses should be cut as soon as possible after heading. Legumes and grass legume mixtures should be cut when the legumes begin flowering.

2) ***Amount of Leaf*** — The feeding value of leaves is considerably higher than that of stems. Loss of leaf in handling decreases feed value. Leaf losses are likely to occur when legumes are cut and raked for hay and can be minimized by harvesting with a swather that has a conditioner attachment.

3) ***Kind of Crop*** — Legumes have higher protein and mineral content than grasses when harvested at comparable stages of growth. (See Figure 5).

4) ***Harvesting Losses*** — Losses of 40 to 50 per cent in feeding value may result when hay is exposed to rain. Rapid curing, collection and proper storage of forage reduces these losses. (See Figure 6).

The quality of hay can only be accurately evaluated by sending forage samples to the Provincial Feed Testing Laboratory located in the Agricultural Services Complex at the University of Manitoba in Winnipeg. It is important to note that the quality of forage may vary from year to year because of temperature and moisture differences.

Protection of hay from the weather is recommended, particularly for hay stored for more than one year. Plans for hay shelters are available through Manitoba Agriculture.

Preserving forage in the form of silage is gaining in popularity. It offers the following advantages:

1) Field losses of nutrients, leaf shattering and/or weathering, are reduced to a minimum. Top quality feed can be put up with little regard for the weather.

2) Feed reserves can be stored cheaply for many years with little, if any, loss of nutrients.

3) A wider variety of crops can be used for forage, permitting more intensive land use. All cereal grain crops and especially barley make good silage, as do all grasses and legumes. A mixture of oats and peas is often seeded for use as silage. Corn is the outstanding silage crop because of its high carbohydrate content.

4) Weedy crops and crops damaged by hail or frost can be salvaged for feed.

5) The harvesting system can be highly mechanized as can the feeding operation. However, it is impractical to transport silage for long distances. Fixed costs of automated equipment and upright silos are considerable and may not be feasible for smaller herds.

Figure 5 — Changes in crude protein and digestible energy of alfalfa and bromegrass with maturity.

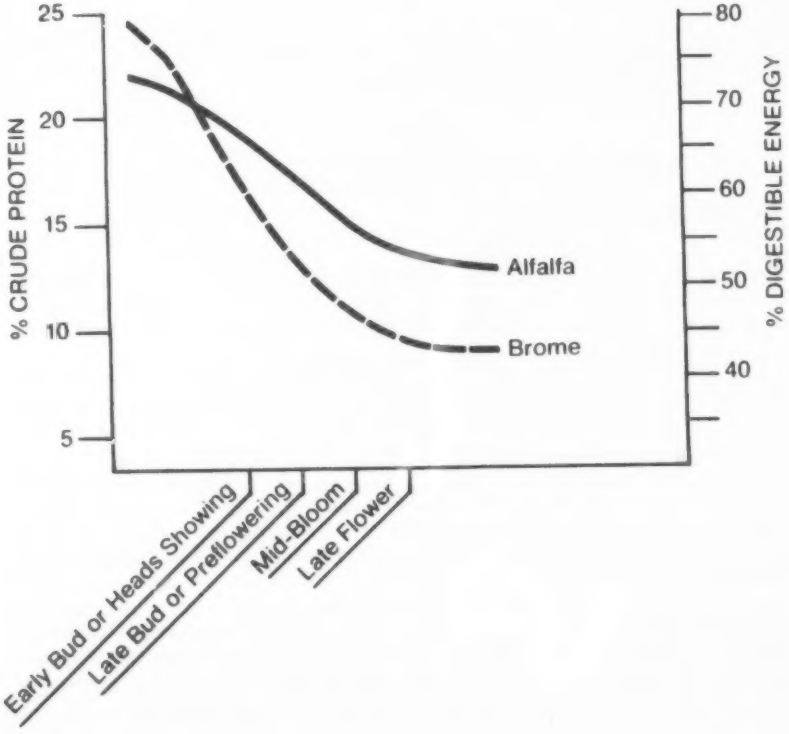
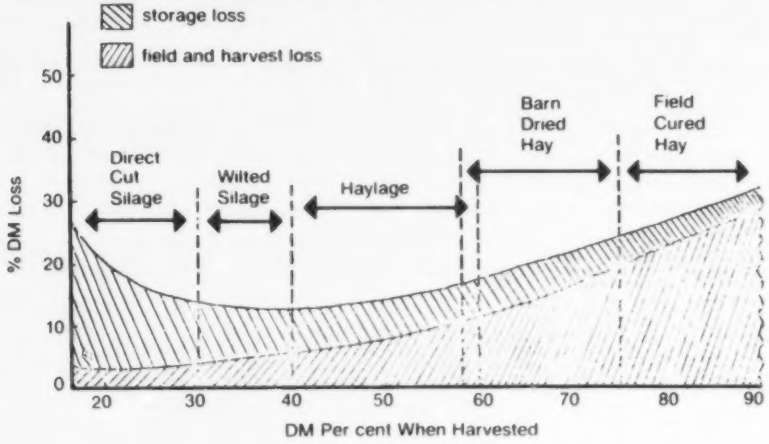


Figure 6 — Estimated field and harvest loss and storage loss.



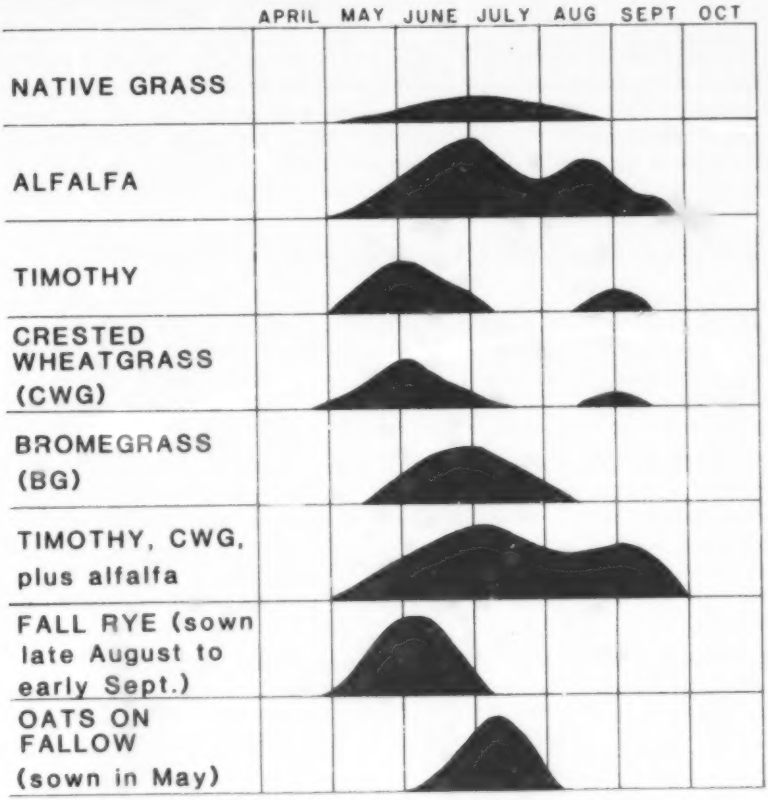
PASTURES AND PASTURE MANAGEMENT

The grazing season can range from as little as three to as much as six months with a properly managed pasture system. Productivity also has a wide variation, depending on forage specie, soil, rainfall, fertility, and grazing management.

Grasses in native pastures and bush areas start growth late in spring. They give best yields when pasturing starts in mid-June and when not over grazed. Crested wheatgrass starts growth early in the spring and has its greatest production in May and June. Bromegrass, intermediate wheatgrass, and alfalfa grow most in June and July. In addition, alfalfa has another peak of production in mid to late August. Annual cereals such as oats and rye will provide good grazing starting about five weeks after seeding.

By taking advantage of variation in growth patterns and seasonable palatabilities of the forage available, producers can extend the grazing season beyond the length of time available from native grass or bush pastures, or from any single grass or grass alfalfa pasture (see figure 7).

Figure 7 — Relative Yield and Period of Growth of Native Grass and Seeded Pastures.



Management of Native Grass Pastures

Most of the native grass pastures have been severely overgrazed, resulting in yields far short of potential. To take pressure off of these pastures and restore them to improved condition and increased yield, seeded pasture should be used in conjunction with native pasture in a complimentary grazing system.

Seeded grass, or grass plus alfalfa, has the ability to produce four to eight times more than native grasses. Using the two in a complimentary system can result in greatly increased production, increased pasture season length and improved native grass condition. The extent of these increases is related directly to the proportion of seeded pasture to native grass. Native grass starts later, grows more slowly, and is sensitive to early grazing and complete defoliation.

To optimize long term production from native pastures, spring grazing must be delayed until June, and livestock should be removed from the pasture as soon as approximately 60% of the current year's growth has been grazed. This pattern of utilization can best be accommodated in a complimentary grazing system.

Other management techniques which will optimize the utilization of native pastures include cross fencing and rotational grazing, the strategic location of watering and/or mineral facilities to promote even livestock distribution over the entire pasture; and the control of brush invasion by means of an on-going chemical or mechanical brush control program.

Management of Cultivated Pastures

Grass-legume mixtures are most commonly used for pasture and they are seldom ready for grazing before May 25. Grazing too early reduces the total yield and will hasten the loss of alfalfa from the stand. Seeded pastures should be rested for three to four weeks at some time during the grazing period if the alfalfa content is to be retained permanently. This is most beneficial if a rest period starts in mid-August.

Crested wheatgrass and timothy are suitable species for spring and fall grazing. Both can be grazed beginning in mid to late May, depending on the earliness of spring. With crested wheatgrass, stocking rates should be heavy enough to remove growth by mid-June because of the rapid decrease in both quality and palatability as soon as the seed head emerges. Rotational grazing offers a number of advantages which should be considered:

1) The rest between grazing periods allows alfalfa to remain more vigorous, thereby maintaining or increasing its proportion in the stand. This means that the nutritive quality of the pasture is maintained or improved and that the requirements for nitrogen fertilizer are reduced.

2) Livestock graze more evenly if restricted to one portion of the pasture at a time; otherwise, they tend to overgraze or undergraze some areas, which reduces productivity.

3) Where conditions permit harvesting surplus pasture as hay or silage, rotational grazing allows the manager to set aside areas for this purpose.

Seed Production

Successful forage crop seed production involves different management techniques than those used for forage production. Seeding rates are significantly lower than those utilized for hay fields or for pastures. Low seeding rates increase seed head formation, and allow better pollination resulting in higher seed yields. For seeding rates and other management practices refer to Pedigreed Forage Seed Production, distributed by the Canadian Seed Growers Association and available through Manitoba Agriculture.

Pollination of red clover, sweet clover and birdsfoot trefoil is undertaken primarily by honey bees. Pollination of alfalfa requires the use of leafcutter bees. Leafcutter bees can be maintained by the grower or can be obtained from a custom pollinator.

Weed control is a limiting factor in seed production. Few herbicides have been registered for weed control in forage seed fields, so the crops must be planted into clean fields. Fields with perennial weeds such as Canada thistle and quackgrass should be avoided. Fields with infestations of weeds with seeds which are difficult to remove from the forage seed should be avoided (i.e. do not seed alfalfa into fields with heavy infestations of sweet clover or wild mustard nor timothy into fields with green foxtail or barnyard grass). Consult the Guide to Chemical Weed Control for specific herbicide recommendations.

Harvesting must be timed so that shattering is avoided, particularly in crops such as timothy or birdsfoot trefoil. Drying of the crop prior to harvest can be aided through use of chemical desiccants. Consult Manitoba Agriculture's Guide to Chemical Weed Control for specific instructions.